Editorial & Publishing Offices :
MACMILLAN & Co., LTD.
ST. MARTIN'S STREET
LONDON, W.C.2

Telegraphic Address :
PHUSIS, LESQUARE, LONDON

Telephone Number :
WHITEHALL 8831

Vol. 144 SATURDAY, NOVEMBER 11, 1939 No. 3654

PHYSICAL ANTHROPOLOGY AND PROBLEMS OF MODERN SOCIETY

WHEN it became necessary during the European War of 1914–18 to assess the physical development and capacities of every man of military age in the British Isles, certain facts emerged which caused no little consternation when they were revealed at a later date. An unduly and unexpectedly large proportion of enrolled men were found to be physically unfit for the more strenuous forms of active service, and many, indeed too many, incapable of any form of military duty abroad. Yet it may be noted that by August 1914, legislation for the medical inspection of school children—the only large-scale provision for the accumulation of evidence relating to the physical condition of the population of Great Britain—had been in force for seven years ; and more than one medical officer for education had directed attention in his reports to whole areas in which a relatively poor physique and under-development pointed to a probability of chronic malnutrition and adverse social and economic conditions. Had these warnings not been ignored, it would have been unnecessary to point out for the benefit of those who expressed in strongest terms their surprise and consternation at the results of this, the first, approach to something in the nature of a physical census of a considerable proportion of the British population, that in this instance, if ever, the child might be regarded as indeed 'the father of the man'. Study of what the child was known to have been would have discounted surprise at the man he had become.

Anthropologists had urged strenuously, but without avail, the inclusion of anthropometric observations in the provision for medical inspection of school children. They were in consequence perhaps a little less perturbed than some by these revelations of the apparent physical inadequacy of the population. Although recognizing the gravity of the situation, they also realized that in the absence of a norm, a properly adjusted standard of physical development according to type, the crude facts as stated lost half their force in argument. A national standard, or an ideal standard, such as the regulation stature and chest measurement required in the recruitment of a peace-time army of picked men, had been applied to a mixed population without regard to the racial differences, which constitute the most striking feature in the physical characteristics of the British population. The same criticism applies to the statements as to under-development among children, in which a general standard correlating age with development is applied without knowledge of the norm in terms of racial differentiation. Obviously the norm of the tall fair Nordic of East Anglia is inapplicable to the short Mediterranean type of the West, yet the short dark operative of the industrial north of England has been characterized as stunted by generations of factory life, without inquiry or knowledge as to the capacity for development of the type in optimum conditions.

The great enthusiasm for the application of scientific method to the study of social and economic problems, and the application of the results in ameliorative action, in the years following on the War, in great measure seems to have passed the anthropologist by, at least so far as concerns the study of the population of Great Britain. Perhaps the anthropologist himself is to blame, and in default of a clear and concrete statement of the application of his studies addressed to the public as well as to those who control the strings of the purse, but are nevertheless swayed

by the trend of public opinion, the study of the racial characters of the population and their distribution must seem academic and remote from reality. Even the arguments of the eugenist, convincing as they may seem to the initiated, lose force when confronted with a demand for a definition of the type towards which eugenic control and conscious selection—for that is what it amounts to—would work, while in the references of its opponents to such approaches to a standard as have been attempted, eugenic studies are frankly twitted with being 'class-conscious'.

Happily it is no longer possible to say that physical anthropology is in default of a re-statement of the possibilities of its aims and methods in relation to the social and economic problems of a modern and—it is unfortunately increasedly apposite to say—post-War society. The due and proper function of the scientific study of these problems, which insistently demand remedy, and will demand it with still more urgency in the social reconstruction which must follow inevitably on the present interruption and disintegration of normal life, is set forth with admirable lucidity in the presidential address delivered before Section H (Anthropology) at the recent Dundee meeting of the British Association, from which extracts are given on another page of this issue of NATURE (see p. 804). It is unnecessary to repeat here the list of inquiries in which Prof. Le Gros Clark holds the co-operation of the anthropologist essential; but bearing in mind what has been said of the racial and regional differences in the British population, the need for a survey of the physical characters of the people, in their regional distribution, of which he indicates the purpose, cannot be too strongly urged. It is an essential preliminary to all valid testimony in inquiries related to the assessment of the physical development of the population of Britain in its many phases.

It is remarkable and by no means creditable to Great Britain as a nation, professing to have regard to scientific methods, that for data relating to problems of growth, on almost every point, we must turn to evidence recorded in the United States of America. Yet as was shown by the valuable research by Miss R. M. Fleming among school children in Wales over a period of years, such observation is not only of signal importance in its bearing upon questions of purely scientific interest, for which data are lacking though the raw material is at our doors, but also it is a crucial index to a number of problems fundamental in testing the physical welfare of the community, and in pointing the way to remedial measures. Thus in the course of the meeting of the British Medical Association in Aberdeen in July last, Dr. Alexander Low submitted an analysis of the anthropometric measurements of more than a thousand infants born in the Aberdeen Maternity Hospital, of whom also fifty males and fifty females were re-examined annually up to the age of five years. From the figures it emerged that these infants were 5–6 ounces heavier at birth than those shown in the published figures for other towns; that after the second year the rate of increase was somewhat greater for girls, so that at the fifth year the girls were slightly superior in weight to the boys; that in height at birth both sexes were somewhat under the usually accepted figures, but that at five years these children were more than an inch taller than Edinburgh and Dundee children.

The regional differences may be noted. Yet in default of fuller knowledge, the only suggestion bearing on the question of the relative increase in height which was put forward was the efficiency of the Aberdeen working-class mother, and her appreciation of the educative value of the child-welfare centre. Whether this is the real and only explanation, without the further knowledge of the facts, which is not available, it is impossible to say, but it makes all the difference to any attempt at ameliorative measures. If the regional variation is due to heredity and not environment, it must be accepted that in all probability any attempt to raise the standard for this one character, provided others show no marked and obvious deficiency, will be largely wasted effort. As Prof. H. A. Harris pointed out in the discussion of Dr. Low's communications, we know more about the embryology and growth of chickens and rats than about humans. At present, Dr. Low's continuous series of measurements is unique for Great Britain, yet, as he argued, it concerns a period of the highest importance for the welfare of the individual.

Reference may also be made to Dr. H. Bathurst Norman's investigation (see NATURE of Sept. 16, p. 518) of the figures relating to the development of adolescents between the ages of thirteen and eighteen years in a public school and in secondary schools in the county of Durham, with the view of arriving at a norm of development in optimum conditions. While the secondary school boys were homogeneous in respect of regional origin, and, therefore, it may be presumed, predominantly of

uniform physical type, it is an equally justifiable assumption that the group of public school boys examined constituted a mixed population. The importance of the distinction is to be seen in the conclusion. In every one of the characters investigated the advantage lies on the side of the public school boy, for which superiority in nutrition is held to account. In regard to stature, however, while some influence is conceded to heredity, that is, racial history, it is inferred that deficiency in nutrition and environmental conditions has precluded attainment of the full development of which the organism was constitutionally capable—a reasonable and probable inference, which cannot be tested, nor if correct, can the degree to which the individual falls short be measured in the absence of any knowledge of the regional or racial type norm for these ages in either class.

Admirable as is Prof. Le Gros Clark's statement of his case, these investigations by Dr. Low and Dr. Norman should clinch the arguments of the physical anthropologist as to the urgency of the need of an extended knowledge of the physical characters of a population of so mixed a character as that of the British Isles. It is not only of academic interest to the man of science, it is also fundamental to full understanding of the many adverse nfluences which mitigate against the building up of a healthy population, developed to capacity, which will be one of the more pressing needs when we turn to repairing the ravages of war.

STATISTICS IN THEORY AND IN PRACTICE

(1) Principles of the Mathematical Theory of Correlation

By A. A. Tschuprow. Translated by Dr. M. Kantorowitsch. Pp. x+194. (London, Edinburgh and Glasgow: William Hodge and Co., Ltd., 1939.) 12*s*. 6*d*. net.

(2) Methods of Statistical Analysis

By C. H. Goulden. Pp. viii+278. (London: Chapman and Hall, Ltd.; New York: John Wiley and Sons, Inc., 1939.) 17*s*. 6*d*. net.

(1) THE original German edition of Tschuprow's book on the theoretical foundations of correlation between two variables is probably not so well-known among English readers as it might be, and we are therefore grateful to M. Kantorowitsch for this translation. Tschuprow (Russian statistician, 1874–1926) was interested in correlation partly from the fashion of his time, and partly from his interest in social science; but his interpretation of the word is a wide one, and many types of stochastic relation are discussed.

Tschuprow was roughly contemporary with the English school of statisticians led by Karl Pearson, and acknowledges the close association between his own treatment and the results of this school. Those familiar with the more recent work of R. A. Fisher and others on small-sample theory will find some of the approximations reached in Chapter vi superseded by exact methods, a bibliographical reference (p. 192) to Fisher's work on normal correlation, and a note (p. 183) by the translator on English statistical literature, helping to close this gap.

Formulæ independent of the population sampled are, however, still of more than historical interest, and it is instructive to see how far Tschuprow was able to go with his theoretical methods; note, for example, his correct surmise on p. 112 that the average value of the criterion χ^2 ($N\varphi'^2$ in Tschuprow's notation) is $N(k-1)(l-1)/(N-1)$ for a $k \times l$ contingency table. The mathematics throughout are not advanced; moreover, all details of the derivations are relegated to an appendix.

Before the more technical chapters dealing with population parameters and sample estimates of them (*a priori* coefficients and empirical coefficients) there are some sections on the meaning of correlation, including a careful distinction between correlation and causality. There is much common sense, too, percolating through the concluding chapter on the object of correlation measurement. The final remarks of all are so pertinent that they are worth quoting in full:

"It is not enough to be familiar with the technical tools; he [the statistician] must be familiar with the subject of the investigation as well, and he must have complete command of his material. He must possess the ability to adapt the technique of his investigation to the end pursued and to the possibilities before him. A routine-like mechanical reliance on ready-made prescriptions leads, even when the most complicated formulæ are employed and the most precise calculations are carried out, to an unproductive waste of time and energy and to the accumulation of numerical values which are but little likely to enrich our essential knowledge."

(2) The second book under review has been written for research workers requiring practical knowledge of statistical methods, and will in particular prove a very useful and comprehensive work for those engaged in agricultural experimentation. There are already other books of similar character, but Goulden has the advantage of being one of the most recent authors in this field, and has been able to incorporate practically the whole of the modern statistician's equipment.

The chapter on the field-plot test contains a summary of the new methods of testing a large number of varieties, developed by F. Yates, and will be welcomed by many workers; it should be noted that the quasi-Latin square design is not mentioned. The rest of the book is fairly standard to one familiar with Fisher's own statistical works, and includes, for example, chapters on goodness of fit, correlation and regression, and analysis of variance and covariance. In the chapter on non-linear regression, where the author uses Fisher's technique in his treatment of orthogonal polynomial fitting, he might have distinguished between the method of orthogonal polynomials in curve fitting and the summation method of finding moments. At the end of each chapter are exercises which are a potential source of value to the thorough student.

Among minor details, the indiscriminate use on p. 80 of both b_{12} and $b_{12.3}$ for a partial regression coefficient is confusing. The meaning of the β's on p. 81 is peculiar to this book. The last figure in the first paragraph of p. 72 should be 0·707, not 0·75. The standard error of a mean does not seem too well discussed (p. 12 and p. 115).

Both Tschuprow's and Goulden's books are on statistical technique; though one is theoretical, the other practical. Their common philosophy, however, is the intimate relation between useful theory and useful practice, so that in spite of the difference in the authors' interests, there is one recommendation that can be made for either work, namely, that it should help its reader to acquire a sound grasp of the true function of statistics.

M. S. Bartlett.

PHYSIOLOGY OF INSECTS

The Principles of Insect Physiology

By Dr. V. B. Wigglesworth. Pp. viii+434. (London: Methuen and Co., Ltd., 1939.) 30*s*. net.

THE most significant change of outlook among entomological workers to-day is the increasing appreciation of the importance of the physiological aspects of their subject. These same aspects are also drawing an increasing number of young zoologists in their search for problems upon which to expend their energies. A great literature already exists on insect physiology, and it is appearing in a disconcertingly wide and erratic range of journals. The consequence has been that keeping up to date with this literary growth has already transcended the possibilities of most entomologists, and Dr. Wigglesworth's book has made a timely appearance in consequence. With evident critical powers and acumen he has done the great service of co-ordinating and sifting out this great accumulation of data and facts and welding it as a whole into a really indispensable text-book. At the same time he has incorporated the results of his own researches, which are distinguished for their originality and for the resourcefulness of the technique that has been used. The general anatomy of insects is outside the programme of this book, and is only dealt with in so far as it may be necessary to make the physiological arguments intelligible. Histology, on the other hand, naturally comes in for fuller treatment since it is intimately linked up with the interpretation of the functions of organs and parts. It is coming to be recognized that rational measures for controlling injurious insects are often dependent upon a proper acquaintance with the physiological 'make-up' of the species concerned. As Wigglesworth remarks, knowledge of the ecology of an insect is necessary in order to achieve effective control, while ecology itself can only be properly appreciated in the light of an understanding of physiology.

The book is divided into fifteen chapters, each being fully documented with its own bibliography. The relative merits of different chapters are hard to assess individually owing to the general standard of excellence of the book as a whole. It is, however, probable that few readers will dispute that Chapter iii is a masterly outline of the phenomenon of growth and that Chapter i, on development within the egg, is possibly too short and sketchy to be as useful as it might have been. Errors and omissions are pleasingly scarce. A few misprints, such as *Menanopus* (p. 327) and *Cioneus oleus* (p. 319), are trivial faults, while the statement about the effects of change of diet in the bee after the second day (p. 60) is probably a *lapsus calami*.

Dr. Wigglesworth is to be congratulated upon having written a work indispensable to all serious students of entomology. It will also be used a good deal by the general zoologist and by the comparative physiologist. Destined to rank as a standard treatise and become also a working handbook, we look forward to its having a long lease of life, and passing through many editions. It is not likely to have any serious competitors for a long time to come. In the next edition an index of authors would be a great advantage.

A. D. Imms.

THE STORY OF PLAGUE AND OTHER TROPICAL DISEASES

A History of Tropical Medicine

Based on the FitzPatrick Lectures delivered before the Royal College of Physicians of London, 1937–8. By H. Harold Scott. Vol. 1. Pp. xix + 648 + 3 plates. Vol. 2. Pp. iv + 649–1165 + plates 4–13. (London: Edward Arnold & Co., 1939.) 50*s*. net.

THESE volumes contain a history of tropical medicine, using that term in its ordinary wide sense. Starting with the Navy and Mercantile Marine, they tell of the dreadful conditions in which seamen lived a hundred and fifty years ago, whether in or out of the tropics, and the still worse quality of the men haled into the Navy by the press gang, so bad indeed that it was not humanity but their quality, their cost, and the effect on the nation that brought pressing to an end just over a hundred years ago. The steady advance in the Army's health in the last hundred years comes out strongly, and the same lesson is seen in the chapters on the Colonies, Protectorates and Dominions, and on India. The main part of the book is taken up with disease caused by organisms and food; and the chapter on plague is an excellent example of its scope and outlook.

When the Philistines captured the Ark from Israel, and when thereafter mice began to mar their land and its people to die of swellings about the secret parts, they sent back the Ark with, in it, golden images of these two things they correlated. On the other hand, the great plague of Athens in 430 B.C. may, Scott believes, have been melioidosis, since Thucydides, who himself recovered from it, mentions no buboes. Again, the Chinese name for plague, 'shu-yi', meaning 'rat-pest', has been traced back to A.D. 610. Plague led to the establishment of quarantine in Venice in 1127, using for segregation the house of St. Lazarus, so giving rise to the names lazaretto and lazar house. It was plague that brought into being Bills of Mortality at the end of the seventeenth century in Great Britain, and from them has grown the science of vital statistics; and about this time, it being announced that none who kept tobacconists' shops suffered from plague, there went out an edict at Eton College the sequel of which was that one of the boys "was never whipped so much in his life as he was one morning for not smoaking". In 1828 came a report from two Frenchmen who held history to show that plague first appeared in Egypt in A.D. 543, about the time when under Christian influence embalming gave place to burial; their conclusion was that the air became heavily tainted with decomposition products and started plague, and they add, "Is there a more conclusive or more notable piece of evidence in any science in which facts are not ascertainable with mathematical certainty?"

The properly controlled scientific certainty, when it came, was very different. Yersin, in 1894, discovered the bacillus in rats and men, and Scott lists fifty-four rodents, other than rats and mice, discovered between 1895 and 1935 to suffer from spontaneous plague. The means of conveyance from rat to man became clear in 1897 when Ogata noted that the plague rat's dead body could safely be handled when cold, that it then had no fleas, and that the emulsion made from a crushed flea, taken off a plague rat, gave plague when injected into a mouse. It was nearly ten years later that the English Plague Commission in Bombay showed that the bacilli, multiplying in the flea's stomach, so fill it and regurgitate into the proventriculus that they readily enter the next mammalian host on which the flea feeds. It is a pertinent comment on the wide interrelationship of biology and human infections that it was some forty years later that Iyengar and O'Connor showed independently that *Microfilaria bancrofti* swallowed by Culex may experience just such regurgitation into the anterior part of the mid-gut before it penetrates the mosquito's tissues.

But to return to plague; there is the pneumonic form with its notable epidemic in Manchuria in 1910; and the occult form in ground squirrels in California, the presence of which is now traced by inoculating into experimental animals the fluid from the bodies of the squirrel's

fleas. Knowledge of plague has been used to save human life, as by the rat-proofing of houses and ships, and to destroy it, as in the Pakar murder case in Bombay; and as to the latter use, there is the observation that the bacilli can survive in tear or asphyxiating gas and perhaps could be used to spread infection in warfare.

The mode of dealing with this single disease illustrates the book's aim and scope: there are first empirical observation and uncontrolled conjecture; they give place to controlled observation and reasoning; and finally there is established knowledge used by man for good or ill.

There are chapters on the making of the Suez and Panama Canals, the latter finished only when tropical disease had been successfully controlled. There is one on the slave trade with its half-million deaths yearly, and to the slaves a water allowance on the voyage of half-a-teacupful every third day; and there is the introduction by its means into America, it seems certain, of leprosy, filariasis, dracontiasis, hookworm infection, yaws, and yellow fever.

The last eighty pages of the work are filled by fifteen short biographies of men, no longer living, selected because their work on tropical medicine has not been limited to one problem, and so has escaped sufficient notice in earlier pages. Bibliography and indexes are generous. Research, learning and humour, amply backed by the publishers' enterprise, deserve success.

CLAYTON LANE.

A CRITICAL AND HISTORICAL SURVEY OF THE CALCULUS

The Concepts of the Calculus

A Critical and Historical Discussion of the Derivative and the Integral. By Carl B. Boyer. Pp. vii + 346. (New York: Columbia University Press; London: Oxford University Press, 1939.) 18*s*. 6*d*. net.

IN the historical survey of mathematics, as of any branch of science, it is customary to ascribe a great discovery to one or more individuals. Without, however, seeming in any way to detract from the full credit due to such brilliant researchers, it must not be overlooked that behind every great step forward there is, invariably, an evolutionary development of ideas which renders that step possible. There are periods of suggestion and anticipation which lead to a stage where the nebulous begins to take form and ultimately becomes precise. But the process does not stop here. A new discovery is somewhat analogous to a roughly-hewn article specially designed for some particular purpose; it will not function to its fullest extent until subjected to a refining development in which greater definition is brought forth, with a consequent extension of the field of validity and useful application. Thus, in time, by a mental process of evolution, any discovery, great as it may be, tends to become less prominent as a separate entity. In the words of J. W. N. Sullivan: "A history of mathematics is largely a history of discoveries which no longer exist as separate items, but which are merged into some more modern generalisation".

An illuminating example of this truth is furnished by the infinitesimal calculus. The mention of this very important branch of mathematics recalls the fluxions of Newton and the differential calculus of Leibniz. Yet, according to Chasles, the greatest mathematician of antiquity, Archimedes of Syracuse, "gave birth to the calculus of the infinite conceived and brought to perfection successively by Kepler, Cavaliere, Fermat, Leibniz and Newton". Thus were the concepts of the derivative and the integral made possible. Yet the calculus as left by Newton and Leibniz was far from satisfactory. There were, for example, no valid criteria for testing the convergence of an infinite series, though both these great men realized the necessity for convergence. Also, the ideas of continuity and discontinuity were far from being clearly understood or appreciated. Hence, the eighteenth century was characterized by considerable doubt concerning the validity of the foundations of the calculus.

"Had Newton been more precise in the statement of his limit method, and had Leibniz been more explicit in professing that he was developing an instrument of invention and not a logical foundation, the period of indecision might not have ensued. As it was, it required the work of Cauchy, Weierstrass and others to impart to the concepts of the continuous variable, the limit, the derivative and the integral a precision of formulation which made them generally acceptable."

Thus does Carl Boyer sum up the deficiencies of the calculus of Newton and Leibniz in his fascinating book, which is the basis of this brief discussion. It seems almost that the eighteenth century of indecision which brought forth the Berkeley-Jurin controversy, the limit conception

of Robins, the "Fluxions" of Maclaurin, the "Calculus" of the Bernoullis and the various contributions of Euler, Lagrange and others, was necessary to prepare the way for the period of rigorous formulation which followed. But the full story is told vividly and fearlessly by Carl Boyer, who traces the development of the basic concepts upon which the modern calculus is founded, from the earliest times to the present day. The eight chapters are filled with interesting facts welded into a continuous narrative which rivets the reader's attention almost like a romantic novel. According to the preface, the author's theme —well described by the sub-title—has not before been satisfactorily dealt with. The book is "not a history of the calculus in all its aspects, but a suggestive outline of the development of the basic concepts"; and a very stimulating outline, too! The author almost makes the infinitesimal, Osgood's "abominable little zeroes", or "the ghosts of departed quantities", the indeterminate ratio 0/0, etc., seem like living characters in a work of fiction.

A comprehensive bibliography is provided at the end and the complete volume is both an important and valuable addition to the literature of mathematics. F. G. W. B.

CHEMICAL ANALYSIS

Standard Methods of Chemical Analysis

A Manual of Analytical Methods and General Reference for the Analytical Chemist and for the Advanced Student. By Dr. Wilfred W. Scott. Fifth edition, edited by Prof. N. Howell Furman in collaboration with Eminent Specialists. Vol. 1: The Elements. Pp. xxxi + 1234 + 97. Vol. 2: Special Subjects. Pp. xxi + 1301–2618 + 97. (London: The Technical Press, Ltd., 1939.) 2 vols., 77*s.* 6*d.* net.

THE rapid growth of analytical chemistry in modern times necessitates that any textbook which hopes effectively to cover the fields of both pure and applied analysis shall assume almost encyclopædic proportions. The considerable increase in the size of this fifth edition of Scott's well-known manual is at least outward evidence that it has attempted to deal adequately with these recent advances, a conclusion which is amply confirmed by a study of the contents. The two volumes of the present edition now cover some 2,700 pages—an increase of nearly 1,000 pages over the fourth edition.

In the first volume, which deals with schemes for the analysis of the more important chemical elements, practically all the chapters have been expanded and, in many cases, re-written. In addition, there have been included, for the first time, methods of analysis for gallium, germanium, hydrogen, oxygen and rhenium. Of these, the first two are not quite as complete as they might be, there being missed from the chapter on gallium Ato's camphoric acid method, which is quite reliable, while no colorimetric procedures are given for germanium. Also, in the determination of oxygen in organic compounds, it is unfortunate that the method given, although neat, is applicable to materials containing carbon, hydrogen and oxygen only. Apart from these points, the new chapters cover the ground adequately. The second and third parts of volume 1 are substantially the same as in the previous editions, although it is to be regretted that the tables of gravimetric factors have been omitted.

The second volume has undergone even greater changes and is now divided into two parts. Part 1 deals with sampling and applied analysis, and here all the chapters have been brought up to date, while many of them have received considerable expansion, particularly those on alloys, petroleum products, rubber and soap. The section on paper and paper-making originally found under "Miscellaneous Analyses" has been enlarged and raised to the dignity of a separate chapter.

Part 2 deals with special techniques applicable in diverse cases, and here are to be found the chapters on acidimetry and alkalimetry, gas analysis, metallography and solubility. New material which has been introduced consists of sections on the determination of *p*H by colorimetric and electrometric methods, potentiometric methods, conductometric methods, chemical microscopy, quantitative microanalysis and spectrographic analysis. All these provide excellent surveys of the various procedures, while in some of the chapters are to be found numerous references regarding the application of the methods to special problems.

The manual is commendably free from errors, although one or two have crept in as a result of rearrangement of the text; also Figs. 25, 243 and 267 do not correspond with the legends beneath them. There has been a typographical change which makes for easier reading, while another welcome change has been the provision of an author index. Altogether, revision has considerably enhanced the value of a work that had long established itself as a necessity to analytical chemists.

SCOPE AND LIMITATIONS OF PHYSICAL ANTHROPOLOGY*

By Prof. W. E. Le Gros Clark, F.R.S.,
University College, London

FOR many years now it has been established beyond doubt that man is one of the terminal products of organic evolution, and that he achieved his humanity at a comparatively recent date in geological time. He was an animal dominated by the primitive instincts of the wild creature before he was a man capable of controlling his own destiny by his intellect. He must be studied as an animal before he can be properly appreciated and appraised as a human being. The subject which is concerned with the study of man from this point of view is physical anthropology, and it may perhaps be claimed that, of all the subdivisions of anthropological science, physical anthropology is the most fundamental, since it concerns itself with the physical nature of man, and the physical nature of man underlies ultimately all those intellectual, æsthetic, and social activities which supply the material for other branches of anthropological study.

Zoological Position of Man

The results of the extensive researches carried out in recent years have served to substantiate in general the views held by most anthropologists, namely, that man has relatively close systematic affinities with the anthropoid apes; in other words, that the human phylum was derived (in the evolutionary sense) from a common ancestral group which also gave rise to the modern anthropoid apes. In a number of details, however, a thorough inquiry into morphological comparisons has led to certain modifications of this generally accepted thesis. The reason for this is that comparative anatomists and palæontologists have come to realize that *parallelism* has played by no means an insignificant part in organic evolution. Now this conception considerably complicates phylogenetic problems, for it makes it necessary to distinguish between morphological similarities betokening real genetic relationship and those which are secondarily acquired as the result of convergence, that is, of evolutionary differentiation which may have occurred in the same direction in different groups independently.

It is interesting to note that, in recent years, detailed and careful comparative anatomical studies have led more and more students to the inevitable conclusion that the evolutionary history of man and the anthropoid apes has been complicated by the effects of parallelism. There remains no justification, however, for taking the extreme view that these higher primates are in no way related to each other. Such a conclusion does violence not only to all the evidence of comparative anatomy, but also to the available palæontological evidence. The very fact that parallelism has occurred between man and the apes indicates that they are *ultimately* derived from a common ancestral stock which endowed them with similar evolutionary potentialities. Moreover, even if it be accepted that the representatives of this ancestral stock could scarcely have manifested the aberrant specializations characteristic of the modern anthropoid apes, it remains reasonably certain that they must have shown in the structure of their brain, skull and dentition, anatomical characters which would demand their inclusion in the zoological category of Anthropomorpha. In other words, it remains true to say that man had a simian ancestry. This relationship is well emphasized in a new classification of mammals recently put forward by G. G. Simpson, for he includes man and the anthropoid apes in one superfamily, Hominoidea.

Palæontological Evidence of Human Origins

Between the Miocene genera of anthropoid apes and the earliest fossil record of man there remains a large gap in the palæontological sequence. The oldest representatives of the Hominidæ of which we have any real knowledge are Pithecanthropus from Java, and Sinanthropus from the early Pleistocene of China. The fact that some anthropologists have classified the remains of these early representatives of man as two different genera is a good example of the results of the difficulties encountered in the study of rare fossils of this type; for, since such fossils usually turn up singly, and often at intervals of several years, each one is made the subject of intensive study without the advantage of adequate material for comparison.

* Based on the presidential address to Section H (Anthropology) of the British Association delivered at Dundee on September 1.

Consequently, the anthropologist tends to exaggerate in his own mind the significance of small structural differences which, after all, may be merely an expression of interspecific or even of individual variation. This now appears to be certainly the case with Pithecanthropus and Sinanthropus, for, since the initial discovery of the type specimens, the remains of a number of other individuals have been found which emphasize the wide range of variation in both groups. Indeed, the overlap in variation between the two is quite considerable, and it is clearly desirable that they should both be included, for purposes of classification, in the one genus, Pithecanthropus.

The range of variation among members of this group may be illustrated by reference to the cranial capacity of adults, which varies from 750 c.c. to 1,200 c.c. Now such a range of variation in the small number of individuals which has been found is very remarkable, for in so ancient a type of man it can scarcely be attributed to the effects of extensive intermixture. The knowledge that this variability does occur should therefore guard anthropologists against making too hasty assumptions on the basis of the study of isolated specimens.

The variability manifested by these early representatives of the Hominidæ serves to emphasize the fact that the range of genetic variation in man is quite exceptional in contrast with lower animals. In other words, man is distinguished physically from other mammals not only by the possession of certain general anatomical characters, but also by the degree of variability which they show. The extent to which these genetic characters can be modified by environmental influences is also a distinctive feature of man. This variability undoubtedly has far-reaching implications in the study of all branches of anthropological science. It seems certain, for example, that it has been an important factor in the evolution of human society, for it allowed a wide range in the development of individual abilities, and also provided for the considerable plasticity which is a pre-requisite for the building up of complex types of social organization.

Future of Physical Anthropology

Apart from palæontology, it may be doubted whether physical anthropology is likely to advance our knowledge of racial origins and differentiation very much beyond its present state with the techniques now available. The reasons for this somewhat pessimistic prognosis include the difficulty of acquiring adequate skeletal material from which the racial composition of populations in the past can be inferred; the frequent impossibility of identifying racial types by the examination of skeletal material only; the fallacy which may be involved in the assumption that certain craniometrical similarities necessarily indicate a true genetic affinity; and the difficulty of eliminating the effects of environmental influences in modifying physical characters which otherwise have a genetic basis.

A valuable aspect of the study of present and past populations from the historical point of view by the rigid application of biometric technique is that it permits the testing of the popular conceptions so commonly held to-day regarding the equivalence of race and nationality. No one will doubt the need for the clarification of such ideas. The physical anthropologist, indeed, has an important duty to fulfil in the discussion of modern social problems, by providing objective evidence to show whether there is any truth at all in the tenet that 'nation' and 'race' in Europe are in any instance comparable terms. Such studies as have been made on this question have hitherto led in general to negative results.

In so far as history can be said to provide a basis for prognostication, physical anthropology as a historical science has a considerable practical significance. The study of the bodily changes which man has undergone in the past gives a clue to the nature and extent of the changes which may be anticipated in the future. *But what is far more important for the same purpose is the study of man as he is to-day.* Sociological problems are becoming more and more forced on our attention and demand for their solution a conscious control of processes which have hitherto been left to chance. The improvement of health and physique and their relation to nutritional and climatic factors, the effects on physical type of the redistribution of the populations of the world, the results of the hybridization of different racial types, the relation of changes in the reproductive rate to human variability and the composition of regional populations, all these are practical problems which can be approached systematically and scientifically only if we have adequate data regarding the physical nature of man in the conditions under which he now lives.

We still lack this essential knowledge. In Great Britain, for example, there are no proper records which show the variability of different sections of the population living under different nutritional conditions and in different environments. Still less is there any real knowledge of the potentialities for growth and development of native populations living under optimal conditions of nutrition and hygiene. Yet a study of the normal variability of man to-day, and of his bodily reactions to environmental influences, must clearly be a necessary basis for any assessment of

changes which are to be anticipated in the future. Let us note briefly the lines along which physical anthropologists may most profitably seek for this information.

Human genetics. The study of human genetics offers practical problems of considerable urgency, for no one doubts that the mode of transmission of hereditary defects, which may be manifested in structural abnormalities, metabolic disorders, or susceptibility to diseases of one kind or another, should be elucidated in all possible detail. The problems of human heredity form the basis of the whole science and practice of eugenics, and the eugenist requires to have all the data of human heredity at his disposal if he is to exert any conscious control over the destiny of mankind in the future.

Apart from the practical significance of human genetics in relation to the health and progress of mankind, this study has also a direct relation to the more academic problems of the anthropologist. Physical anthropologists have on several occasions been criticized for employing as criteria in their studies of racial affinities physical characters the genetic basis of which is unknown. No doubt such criticism is often justified, for it is clear that only those characters which are the expression of genic differences have any validity in taxonomic problems. There is evidence that the shape of the head is certainly in part determined by heredity, but there is also evidence that it can be modified by post-natal influences. Similarly, it is well recognized that the height of an individual is closely correlated with nutrition, but it is known that it also depends partly on heredity. The relative importance of genetic and environmental factors must ultimately be determined for all such characters as these.

The question of the possible linkage of phenotypic characters is another problem of human genetics which demands intensive investigation, since this phenomenon may permit the recognition of latent defects in cases where they are linked with a physical trait detectable by superficial observation or appropriate measurement. The possible relation of physique to susceptibility to disease is particularly important. It is commonly supposed that a relation of this kind does in fact exist. Physical types, such as those termed 'asthenic', 'pyknic', and 'athletic', have been defined, each with their particular advantages and weaknesses; but, so far, the evidence in favour of such a sharp classification is equivocal, and the same doubt still applies to the supposition that certain racial types are particularly susceptible to infections of one kind or another. For example, there is a current belief that the Negro, as the result of an inherited predisposition, is specially liable to tuberculosis, and that certain types of racial miscegenation likewise lower the resistance to such diseases. Yet in a recent and careful survey by Williams and Applewhite, the conclusion is reached that there is little if any difference between the White and the Negro in resistance to tuberculosis (given equal opportunities for medical treatment), nor do miscegenetic types of the Negro really show a greater incidence of tuberculosis.

The possibility of a genetic linkage of characters also raises the question how far inherited physical traits may be related to an inherited mental disposition. It is common enough, in text-books on anthropology, to find different varieties of temperament assigned to different racial types. For example, it is stated in a recent comprehensive work on human heredity (by Dr. Lenz, professor of racial hygiene in the University of Munich) that the Mediterranean race (of which, in Europe, the southern Italians are perhaps the best representatives) is volatile and frivolous in temperament, has less sense of truth and honour than the Nordic, and, in respect of rational endowment and character, occupies an intermediate position between the Nordic and the Negro. The Nordic race, on the other hand, is supposed to be endowed with creative energy, with a vigorous imagination, high intelligence, and an unusual degree of self-control.

Physique and nutrition. The problems of human genetics and the supposed association of mental traits with demonstrable physical characters are complicated by the growing recognition during recent years that nutrition plays a highly important part in determining the physical variations seen in different races and in different individuals. It is unnecessary to state that a broad relation between nutrition and physique has always been accepted by anthropologists. Stature, weight, chest-dimensions, and so forth, can all be correlated with nutrition. But the suggestion is now put forward by competent dietitians that the effects of malnutrition may be much more extensive, not only as causal agents underlying many types of variation in physical characters, but also in determining susceptibility to different types of infection. If this is true (as it undoubtedly appears to be) it clearly demands the serious attention of physical anthropologists.

In Great Britain, indeed, evidence has been put forward which suggests that malnutrition may be far more extensive in the lower economic levels of society than has hitherto been suspected. Clinical and anthropometric comparisons of the children of relatively wealthy parents with those of poor parents have demonstrated a marked contrast in physique, general health, and susceptibility to infections. There is evidence, for example, that

the infantile mortality from respiratory infections is considerably higher in the poor districts of large towns than in the residential areas of the richer sections of the population, and there is also evidence that the predisposition to respiratory infections is related to under-nourishment. Moreover, direct experiments (although of a limited nature) have been carried out on human material in which the effects of different diets on growing children have been recorded.

It will not be doubted that, if there is indeed widespread malnutrition, it is a matter of national interest that it should be corrected as soon as possible. But an essential preliminary to any large-scale plan of action is to collect precise information regarding the extent, distribution, and degree of under-nourishment. Here is a problem in the solution of which the physical anthropologist should play a predominant part. He has at least the experience and technique which will enable him to seek an answer to one of the most urgent preliminary questions: By what somatometric method, which is both reliable and convenient of application, is it possible to assess nutritional status?

It is perhaps a matter for surprise that in Great Britain we still have no adequate standard of what may properly be called *normal* physique, as a basis for comparison when seeking for evidence of malnutrition. This is partly due to the fact that available anthropometric data apply to mixed populations from different parts of the country, in which no attempt has been made by careful clinical examination to eliminate those individuals who may be under-nourished, or otherwise unfit physically. It is also a fact that the physical standard is by no means fixed and unchanging. There is evidence, for example, that the average height of the population, not only in Great Britain but also elsewhere, is rising rather rapidly, and it has been recently estimated that this increase may be as much as one centimetre in every 12½ years. It is possible that this increase is directly referable to improved nutrition, though there are some reasons for supposing that this explanation may not be completely adequate. It remains conceivable that it may possibly represent a definite orthogenetic trend in human evolution which is manifesting itself in statistical analysis.

In order to obtain a basic standard of physique (or series of standards) for comparative studies, it is in the first place necessary to carry out a complete survey of the country by the systematic examination of samples of the population from different districts. Such a survey would require the close collaboration of physical anthropologists with clinicians, medical officers of health, dietitians, and social workers, in order to attempt a correlation between physical development and the normal healthy condition of body and mind, and, if possible, to relate this also to the social conditions of life. In fact, an attempt should be made to extend the health surveys which have been recently carried out in Great Britain and a number of other countries, the aim of which has been to correlate also the clinical assessment of nutritional status with anthropometric observations.

Observations on the relation of nutrition to physique, capacity for work, and susceptibility to disease are also waiting to be carried out among native peoples in many parts of the world. Some excellent work along these lines has been started in India, Africa, and also in China, where information has been collected regarding the composition of the diet of different sections of the native population. Here the field anthropologist must necessarily give his aid, since he is in the best position to obtain a detailed record of the food elements of the diet which are ordinarily obtainable at different seasons, to study the local customs in the preparation of the food for consumption, and also to collect samples of the various foodstuffs for analytical study by the biochemist. It has already become evident from such observations that in some cases the native diet is hopelessly deficient in certain essential food elements which are necessary for the development of a normal physique and for the maintenance of health. The elucidation of such defects in the diet must surely in the future be a powerful factor for success in colonial administration.

To carry out nutritional surveys in native populations, the physical anthropologist will also require to examine the somatometric indexes which have been worked out by reference to European peoples, for they will probably need modification to adapt them to different types.

The fields of research to which we have directed attention serve once more to emphasize the fact that the physical anthropologist of the future must be essentially a field-worker if he is going to develop his subject along progressive lines. He must also be a man of sound biological training if he is to acquire a real insight into the problems which are set for him. Some of these problems have a very intimate relation to human happiness and human suffering, and their investigation is a matter of urgency.

The science of physical anthropology has contributed much to the study of the past history of the human species. By the study of modern populations it has a still more important function to fulfil: the accumulation of data on the basis of which it will be possible in some measure to control the destiny of mankind in the future.

SOLAR AND TERRESTRIAL RELATIONSHIPS

A DISCUSSION on solar and terrestrial relationships had been arranged to take place on September 5 as part of the programme of Section A (Mathematical and Physical Sciences) of the British Association meeting at Dundee. The meeting was not held, owing to the international situation, and the following account contains the subject-matter of contributions from Dr. E. V. Appleton (radio effects), Mr. H. W. Newton (solar phenomena and terrestrial magnetism), Dr. A. D. Thackeray (solar phenomena), Prof. L. Vegard (auroral phenomena and the physics of the upper atmosphere), Prof. W. M. H. Greaves (the 27-day recurrence tendency of magnetic storms) and Prof. F. J. M. Stratton (general summary).

Many attempts have been made in the past to correlate solar and terrestrial phenomena. Until quite recently, the only one that was found to show a clearly measurable relationship was that between sunspot activity, auroras and magnetic activity. There is no direct meteorological effect of any serious importance, although in some climates tree-rings suggest a connexion of a complex type with the sunspot cycle not shown up by ordinary data. The recent study of the ionosphere has shown a new relation, involving an increase in ionization in the upper atmosphere accompanying increased magnetic activity at times of maximum sunspot activity; this relation appears in a peculiarly clear-cut fashion at times of chromospheric eruptions which closely coincide with short-wave radio fade-outs. The correlations so far found can all be attributed either to a stream of corpuscles ejected radially from the sun's surface or to an increase in ultra-violet solar radiation.

Nearly every type of solar activity is capable of emitting a stream of particles or high-frequency radiation which may ultimately strike the earth's upper atmosphere. In the lowest levels of the sun's atmosphere, direct observation reveals sunspots, faculæ and granulation; with the spectroscope, high-level flocculi and prominences are detected (chiefly in hydrogen or ionized calcium light); still higher, coronal streamers suggest a permanent outward flow of particles. Eruptive prominences, which may ultimately attain velocities of the order of 600 km./sec., form a spectacular example of the sudden expulsion of matter from the sun, presumably through radiation pressure; the motions of prominences, however, as revealed by cinematography, show many characteristics which are difficult to explain even in terms of a complex interaction of radiation pressure, gravitation and electrical forces.

Radiation pressure is insufficient to support the whole mass of chromospheric gases, but the dynamical concept of turbulence has partially solved this difficulty. A turbulent velocity of 15 km./sec. in the chromosphere is indicated; in the lower layers it is on a much smaller scale. The short-lived granules, with a life-time of only three minutes, represent permanent activity all over the sun's surface, *independent of the* 11-*year sunspot cycle*, while chromospheric eruptions represent temporary localized activity on a large scale. These eruptions consist of intense brightenings in hydrogen and calcium light which sometimes last only a few minutes. Thanks to the spectrohelioscope, perfected in 1924 by Hale, a practically continuous watch for these short-lived phenomena is now kept throughout all longitudes by international co-operation. It has been found that 50 per cent of the brightest eruptions are associated with *simultaneous* radio fade-outs; with the fainter eruptions the association is much less direct.

The statistical relationship between sunspots and magnetic storms may be summarized as follows: (*a*) there is a general similarity in the frequency curves of the two phenomena in the 11-year cycle; (*b*) the largest sunspots, at the time of their passage across the central solar meridian, are often associated with large magnetic storms; (*c*) the most favoured position of the associated sunspot at the time of the magnetic storm is about one day past the central meridian. The time-lag suggests the time of travel of a stream of particles from sun to earth. The relationship becomes progressively more obscure when smaller spots are studied.

It is natural to inquire whether this relationship is due to the presence of chromospheric eruptions, which are most commonly observed in or near large active sunspots. A distinct relationship has been established between eruptions and magnetic storms, similar to that with sunspots. Of the twenty-nine greatest eruptions observed since 1892, twenty-one were found to be followed within 4·0 days by a magnetic storm, and half of these storms were classified as 'great'. Magnetic storms do in fact appear to be more closely associated with chromospheric eruptions than with sunspots.

The association of chromospheric eruptions with ionospheric disturbances is of a different character: (*a*) there is no time-lag; (*b*) the eruption can be effective wherever it occurs on the solar disk;

(*c*) the ionospheric disturbance is practically confined to the earth's sunlit hemisphere; (*d*) there is an accompanying small perturbation of the earth's magnetic field. These four facts are consistent with the suggestion that the solar agency is ultra-violet radiation emitted from active regions of the solar surface. The agency responsible for magnetic storms, however, is to be looked for in a radially ejected stream of high-velocity particles. The observations favour a common origin of radiation and particles in an active portion of the sun's surface, which may also but not necessarily be marked by a large sunspot. The association of terrestrial phenomena with sunspots must be regarded as an indirect one; it is only because they are so easily observed that sunspots have been taken as a convenient index of solar activity.

A further relationship between sunspots and terrestrial magnetism is shown by the fact, known for many years, that magnetic storms tend to recur at intervals of one synodic solar rotation (about 27 days). A catalogue of 403 storms based on Greenwich records for the years 1874–1927 has been used to study this relationship in detail. These were divided into five groups according to intensity, represented by the mean of the three components *D*, *H* and *V*. The history of storm-days following each storm was followed up and the tendency to recur after 27 days was found to be confined to the less intense storms (less than 180 γ): in the weakest storms (less than 150 γ), there is a definite additional tendency to recur at intervals of 54 days.

This result can be expressed in another way: if attention is confined to storms which tend to recur after 27 days, it is found that the ratio 'sequence storms' to all storms decreases progressively from 0·25 to 0·05 as one passes from weak to great storms. This result does not contradict the conclusion that magnetic storms are due to radial streams of corpuscles from active regions of the sun; it merely suggests that the most intense solar disturbances which eject such streams are comparatively short-lived and will not survive a solar rotation. The 27-day recurrence has been found to persist throughout spotless periods of minimum activity; thus, as implied previously, the spots themselves must not be regarded as the origin of the corpuscular streams.

The frequency of auroras has long been known to follow the cycle of solar activity; there is also a slight tendency for intense auroras to occur near the times of the equinoxes, when the earth lies in the plane of the equatorial belt of the sun where activity is greatest. The spectrum of auroras consists of bands (chiefly due to nitrogen) and lines (due to atomic oxygen and nitrogen, neutral and ionized). The wave-lengths of the strong green and red lines have been measured with great accuracy, and, with the help of knowledge of atomic energy levels, attributed to 'forbidden' transitions of neutral oxygen.

The presence of ionized oxygen and nitrogen indicates the action of particles of high energy. The work of Störmer has shown how the streamers may be identified with the paths of electrified particles entering the earth's magnetic field. Analysis of the intensity distribution within auroral bands yields a mean temperature determination of $-44°$ C. There is no evidence of any increase in temperature with height either from band analysis or from measures of interferometer fringes of atomic lines. Further, the observed light intensity along auroral streamers suggests that the density of atmospheric gases diminishes but slowly within the auroral region from 100 km. to 800 km. It is suggested that matter is driven to these heights by electric forces in an ionized or partially electrified atmosphere.

A theory proposed by Vegard in 1923 accounts for the main facts on the assumption of a stream of photon radiation, the wave-length of which corresponds to soft X-rays, in addition to the ordinary temperature radiation and corpuscular rays emitted by the sun. The incidence of this radiation on the extreme upper atmosphere produces a sort of terrestrial corona. The theory has been very successful in explaining the chief layers of ionization in the upper atmosphere. The soft X-rays will produce two ionization maxima; the first, formed at a high altitude by high-speed photo-electrons, is identified with the F_2 layer, which surrounds the whole earth, but is higher by night than by day; the second, at a low altitude where the absorption per unit length is a maximum, is identified with the *E* layer, which is confined to the sunlit hemisphere. The energy of the photons must be about 1000 volts to account for the observed heights of the *E* and F_2 layers. Finally, the absorption coefficient for rays in a large range of wave-length (100–1000 A.) is a maximum, so that these rays will produce an ionization maximum at about the same height—calculated to be 200 km.—which will be confined to the sunlit hemisphere. This maximum is identified by Vegard with the F_1 layer.

The variations in ionization in these three layers may be very efficiently studied by means of the radio sounding method, developed by Appleton and others. The ionosphere may, in fact, be regarded as a solar laboratory in which the effects of high-frequency radiation and particles emitted by the sun may be analysed. By timing echoes of vertically transmitted waves, a relation is obtained between equivalent height of reflection and

radio-wave frequency. At a critical frequency, echoes from the ionosphere are lost, and this gives a clue to the maximum electron density in any layer. Layers E and F_1 show comparatively smooth diurnal, seasonal and sunspot-cycle variations, all of which confirm the supposition that these layers are produced by high-frequency solar radiation. The long-scale variations in ionospheric reflectivity do, in fact, give a very perfect reproduction of the 11-year cycle of solar activity. The ionization in layer F_2, however, suffers remarkable irregularities, particularly during magnetic storms, when the ionization maximum is less than normal. The most striking type of ionospheric irregularity is that known as an irruption or fade-out, which is usually associated with a chromospheric eruption. Here the absorption is so great that the echo may be entirely lost, but the height of reflection is not usually greatly affected.

The question of the ultimate character of the short-wave solar radiation associated with these disturbances (for example, its frequency and whether it consists of continuous or line-emission) is still quite unsettled. The spectrum of chromospheric eruptions in the observable range has been found to consist of lines due to H, He and Ca^+. Photometric measures show that during an eruption, the total Hα radiation from the sun increases by only a few tenths of one per cent; it is quite clear that what the spectrohelioscope observer sees is a secondary effect, and that the primary disturbance consists in the leakage of unobservable ultra-violet radiation. As Milne has pointed out, given an increase of radiation, the ejection of a stream of high-speed particles is easily accounted for by radiation pressure. Lyman emission of hydrogen is insufficient to account for all the observed effects, and it is probable that we have to deal with a mixture of line and continuous radiation. Continuous emission is not normally observed in the visible region, although a small increase at wave-length 3220 A. has been detected in one exceptional eruption.

Further analysis of ionospheric disturbances by radio sounding probably holds out greater hopes for the ultimate solution of the problem than the observation of secondary solar effects in the visible spectrum. Finally, the spectra of 'sunlit auroras' recently observed by Störmer promises a fruitful field for research into the uppermost regions, where the solar rays first strike the earth's atmosphere.

OBITUARIES

Sir William Pope, K.B.E., F.R.S.

WILLIAM JACKSON POPE, the great chemist, was the eldest son of William and Alice Pope who at the time of his birth (March 31, 1870) lived in New North Road in the City of London. On leaving the Cowper Street Endowed School, Pope proceeded to the Finsbury Technical College, where he was one of H. E. Armstrong's earliest pupils. He followed Armstrong to the Central Institution (now the City and Guilds' College of the Imperial College of Science and Technology), where the scheme of scientific studies having no reference to outside examining bodies did not lead to a university degree but gave Pope a rigorous training in chemistry, classical crystallography (under H. A. Miers) and in research methods admirably suited to his genius. From that time dated the unique friendship between Armstrong and Pope which was only broken by the former's death in 1937.

While still a student, Pope began his own crystallographic investigations of organic compounds. He also collaborated with F. S. Kipping, then Armstrong's assistant, in important investigations in the chemistry of camphor and on the constitution and characterization of externally compensated compounds.

Pope's first appointment (1897) was that of head of the Chemistry Department of the Goldsmiths' Institute at New Cross, and at the same time he was lecturer on crystallography at the "Central". In 1901 he became professor of chemistry and head of the Chemistry Department at the newly built School of Technology, Manchester, becoming professor of chemistry in the University of Manchester in 1905, when the School was made the centre of the Faculty of Technology, and on that occasion Pope received his first university degree; he had been elected to the fellowship of the Royal Society in 1902. Pope was elected to the professorship of chemistry in the University of Cambridge in 1908 in succession to J. D. Liveing, who had held the chair for forty-seven years, and in the following year he was elected to a professorial fellowship at Sidney Sussex College.

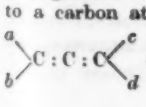
Pope's enduring fame will rest chiefly on his work on molecular dissymmetry. Pasteur had laid the foundations of stereochemistry in 1849, and up to the time of Pope's work at the Goldsmiths' Institute, all the optically active compounds studied by Pasteur and his successors contained in the molecule at least one carbon atom having an asymmetric environment. The presence of this 'asymmetric carbon atom'—a carbon atom united to four different atoms or groups tetrahedrally arranged round it—in the molecule was up to then regarded as being essential for the particular compound to be capable of exhibiting optical activity. As Pope has frequently pointed out, it is probable that the use of this

particular phrase with its narrow implication tended for many years to delay progress in stereochemistry, since it became usual to correlate the exhibition of optical activity with the asymmetry of a particular atom present rather than with the dissymmetry of the molecule as a whole. By the optical resolution of externally compensated compounds in which the atoms nitrogen, sulphur, tin and selenium had asymmetric environments, Pope was the first to show that the presence in the molecule of a carbon atom having an asymmetric environment was not essential for the exhibition of optical activity. In this classical work he had as collaborators S. J. Peachey, A. W. Harvey, E. M. Rich and H. A. D. Neville, and its success and that of numerous chemical and stereochemical investigations carried out simultaneously depended on Pope's knowledge and use of crystallography and also on his introduction of the use of the camphorsulphonic acids, first adequately described by Kipping and himself, for the resolution of externally compensated bases.

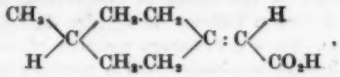
During the Manchester period, Pope had as assistants C. S. Gibson and John Read. With Peachey he prepared the first organic compounds of platinum and with Gibson those of gold, and this work, so novel and simple in its conception, was typical of Pope's knowledge and genius in attacking fundamental problems. Another striking example of this was the elegant work carried out with Read which resulted in the resolution of externally compensated chloroiodomethanesulphonic acid, $CHClI.SO_3H$. This work showed that it is only necessary for the attachment of four different atoms or groups, none of which need contain a carbon atom, to a single carbon atom to condition stable optical activity. This compound is still the simplest substance showing permanent optical activity. At this time also, Pope and Read began the work which resulted in the introduction of optically active oxymethylenecamphor as alternative to the use of the camphorsulphonic acids for the resolution of externally compensated primary and secondary amines.

Since his student days, Pope had been profoundly interested in the relation between chemical constitution and crystalline form. For many years he and W. Barlow worked on this subject, and beginning in 1906 they published a series of long and detailed papers in which the valency volume theory was developed. After some time it became evident that the fundamental conceptions on which the theory was based were too circumscribed, but the work they carried out has considerable value in the history of the subject which has been so ably developed by Sir William and W. L. Bragg and other workers.

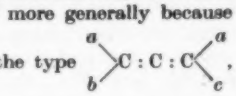
Following Pasteur, van't Hoff had realized that organic substances can be formulated which have enantiomorphous configurations and yet contain no carbon atom having an asymmetric environment. He showed that on account of the tetrahedral arrangement of the atoms or groups attached to a carbon atom, allene derivatives of the type



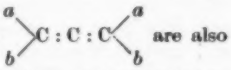
should exist in enantiomorphously related forms and therefore be capable of exhibiting optical activity. Pope realized that the compound 1-methyl*cyclo*hexylidene-4-acetic acid,



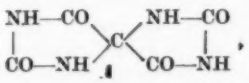
which has an enantiomorphous configuration and contains no carbon atom having an asymmetric environment, resembles the above type, and he and W. H. Perkin (then colleagues in Manchester) commenced its synthesis in 1903 and completed it in 1906. Later they were joined by O. Wallach, and adequate quantities of the compound became available for the resolution experiments. In the latter, Read played a leading part, and the successful accomplishment of this difficult piece of work constituted a most important development in stereochemistry. Actually, as Pope also showed, van't Hoff might have stated the case more generally because the above compound is of the type



and compounds of the type



are also theoretically capable of exhibiting optical activity. In immediate extension of this work, Pope and his co-workers obtained striking proof that organic compounds can retain their configuration throughout a series of reactions in which the molecular symmetry undergoes profound change. A further example of this is his work with J. B. Whitworth on *spiro*-5 : 5-dihydantoin,



probably the most complete and detailed stereochemical and crystallographic study published in recent years. Pope's work on 1-methyl*cyclo*hexylidene-4-acetic acid has been responsible for almost all the developments in stereochemistry by many workers during the last twenty-five years, owing to the fact that he defined the conditions of mirror-image isomerism, namely, that for mirror-image isomerism the molecular configuration may possess any elements of symmetry excepting a centre of symmetry or a plane of direct symmetry.

Apart from his acknowledged pre-eminence in crystallography and stereochemistry, Pope carried out outstanding work on photographic sensitizers (with W. H. Mills), on the direct synthesis of 'mustard gas' (with C. S. Gibson) and on the extension of Werner's theory of the configuration of complex co-ordination compounds to those containing tri-amines and tetra-amines (with F. G. Mann).

Pope was president of Section B (Chemistry) of the British Association (1914), president of the Chemical Society (1917–19), president of the Society of Chemical Industry (1920–21), president of the Union internationale de Chimie (1922–25), president of the Federal Council for Chemistry (1918–35), president of the Solvay Chemical Conferences (1922–36) and

Prime Warden of the Goldsmiths' Company (1928–29); he had been chairman of the City and Guilds of London Institute since 1932. He was created Knight Commander of the Order of the British Empire in 1919 and Grand Officier de l'Ordre de Léopold two years ago. He was honorary member of no less than twelve foreign academies and a member of at least ten British scientific societies. He received the Davy Medal (Royal Society), the Longstaff Medal (Chemical Society), Dumas Medal (Société de Chimie industrielle), Lavoisier Medal (Société chimique de France) and Messel Medal (Society of Chemical Industry), besides the honorary doctorate of seven universities.

All who had dealings with Pope, whether as friends, collaborators or pupils, could not fail to be impressed by the true greatness of the man. He was extremely well informed in English and foreign literature and in affairs generally; his judgment and advice were invariably sound. Actually Pope was very shy, but in conversation he was brilliant and witty and few could tell a good story better than he. He was a charming host and loved the company of his friends and life generally. He was a connoisseur and his collections of alchymical pictures, chemists' mortars and drug pots are unique; his library of chemical and general literature has long been the envy of many colleagues. Pope was a most graceful speaker in English as well as in French and German; he could easily translate the spoken word from French directly to German.

For some years Pope had been in poor health, against which he struggled with amazing fortitude, and he continued to carry out his duties and perform extra tasks which must have taxed him greatly. During the last three years he suffered intensely and he bore his sufferings in silence. The end came on October 17 and, after a quietly dignified service taken by his friend, the Master of Sidney Sussex College, his body was cremated in Cambridge.

"Post tenebras lux"

Charles S. Gibson.

Prof. Albert Gilligan

By the death of Albert Gilligan at Storth, near Milnthorpe, on October 14, the science of geology has lost an able exponent. Born on July 26, 1874, he was educated at Wolverhampton Grammar School and at University College, Cardiff. After service as science master at Glossop County School, Gilligan joined the geological staff of the University of Leeds as assistant to Prof. P. F. Kendall. Under the influence of Kendall he became interested in physical geology, particularly that of Yorkshire, and his first published work recorded the denudational effects of a severe storm in that country. This interest remained with him throughout his life.

Gilligan had the ability to lecture in a clear and enthusiastic manner, easily understood by non-geological audiences, and in so doing, perhaps, he rendered his greatest service to the science of geology. For many years he gave series of lectures throughout Yorkshire, many to the mining community, others to societies of many kinds, and through these made many converts to geology. Gilligan also encouraged the work of local geological societies, and his services were always at their disposal for a lecture or a description in their journals of a local section.

Later, Gilligan became interested in sedimentary petrology, a branch of geology then overshadowed by the igneous side of petrology. He developed a technique of heavy mineral analysis, and turning his attention to the Millstone Grit, continued the work on its sedimentation initiated by Sorby. In 1920 he read the results of this pioneer investigation before the Geological Society of London, and in 1921 he was awarded the Murchison Fund of that Society. He had in 1920 been made reader in geology in the University of Leeds and in 1922 he succeeded Kendall in the chair of geology.

His work on the Millstone Grit had led Gilligan to the problems of Middle Carboniferous palæogeography, and in 1929 he gave, as his presidential address to the Yorkshire Geological Society, an address entitled "A Contribution to the Geological History of the North Atlantic Region" in which he summarized the evidence for a Palæozoic and Pre-Palæozoic 'Atlantis'.

From 1922 Gilligan was curator of the Cecil Duncombe Observatory, and he did much to foster the study of astronomy. He also played his part in the administration of geological societies, serving on the council of the Geological Society. In university administration he was closely concerned with student activities especially in athletics, and he did much to promote friendly relations between staff and students. He had a sincere understanding of the difficulties of students whose lack of means handicapped their studies, and many have cause to be grateful for the ready help which Gilligan so often generously gave.

Gilligan was a delightful companion in the field, keenly interested in archæology and natural history. It is the regret of all his friends that he was not permitted to enjoy, in the foothills of the Lake District, his retirement from academic labours.

R. G. S. H.

We regret to announce the following deaths:

Prof. A. Busi, professor of radiology in the University of Rome, aged sixty-five years.

Vice-Admiral Sir Percy Douglas, K.C.B., C.M.G., hydrographer of the Navy during 1924–32, on November 4, aged sixty-three years.

Mr. R. C. Lambert, librarian at the Athenæum Club during 1922–35, on November 5, aged seventy-one years.

Prof. C. F. Shaw, professor of soil technology in the University of California, on September 12, aged fifty-eight years.

Dr. J. H. T. Tudsbery, honorary secretary, formerly secretary, of the Institution of Civil Engineers, on October 10, aged eighty years.

NATURE

SUPPLEMENT

Vol. 144 SATURDAY, NOVEMBER 11, 1939 No. 3654

THE SEVENTH INTERNATIONAL CONGRESS OF GENETICS

THE Seventh International Congress of Genetics was unique in more than one way. As described by Prof. Crew in NATURE of September 16, p. 496, it was held during a period of high political stress, and it accomplished something that perhaps no other international congress will be required to attempt again. The enthusiasm of the six hundred men of science present, combined with a well-thought-out organization, retained the attention and support of all geneticists who were present in Edinburgh during an eventful week of turmoil. The following pages provide a survey of the proceedings.

The Congress not only achieved success in the work of the sections, but will also be remembered in at least one other direction. The exhibits, which included charts, diagrams, photographs, together with dead and living material of plants and animals, occupied the laboratories of the new Zoological and Engineering Departments of the University of Edinburgh. Under at least a hundred and fifty microscopes (probably many more) were slides illustrating most of the branches of cytology. These exhibits enabled one to see for oneself how great was the advance in cytological technique, to see perhaps for the first time heterochromatin or chromosome splits, and to judge the grounds on which controversial matters were based. The plant exhibit in the laboratory ranged from magnificent demonstrations of the origins of maize, the genetics of wheat hybrids, and the cyto-genetics of Datura, to the illustration of scientific method in the analysis of the peculiarities of fruit crops and plant pigments. In addition, there were living exhibits of genetic characters in a number of plant species. One laboratory was filled with charts and diagrams recording the genetics of Drosophila and physiological actions of the genes, while another laboratory contained exhibits on the inheritance of colour in the cocoon of the silkworm, and the diseases to which man is subject. A large exhibit of animal genetics covered the inheritance of characters in rodents, rabbits, and other animals. A notable feature was the organization by Dr. Koller of an exhibit of living plants of Pisum, Lycopersicum, Primula, Antirrhinum, Nicotiana and other genera. These were arranged to illustrate the characters which are controlled by known genes. One of the crops was so well grown that members of the Congress who were specialists on this crop were able to use the plants for observational purposes.

It is obvious that the success of the Congress was due to the excellent organization of Prof. F. A. E. Crew, his committee and staff. Both previous to the Congress and during the Congress in normal times the position of the general secretary is an onerous one. When each day of the Congress brought more news and rumours of war, it was doubtful whether the Congress could continue. By a complete reorganization, only possible by excellent team work, the sections were able to complete their work, the exhibits were received, erected and dispatched in safe custody, and each individual member of the Congress who was directly or indirectly affected by the political upheaval was made to feel that he was being personally looked after by the general secretary and his able staff.

Science will not falter so long as the spirit initially engendered by the staff of the Institute of Animal Genetics at Edinburgh and propagated by the members of the Congress continues among the research workers of the world.

GENE AND CHROMOSOME THEORY*

By Dr. H. J. Muller

THE treatment of gene and chromosome theory was on a far more analytical plane than ever before. Thus, the multiform variations of behaviour of chromosomes at meiosis, and the rules governing these variations, were shown by Darlington to trace back to variations in two primary factors: the region (centric or telic) in which pairing begins, and the time limit set to the pairing process; normally, these must be adapted to each other, so that a mixing of two systems tends to disturb the balance.

Regarding the mechanism whereby structural changes in chromosomes come about, a series of experiments by the present author and co-workers was reported, substantiating and extending, for Drosophila, the earlier conclusions of Stadler, of McClintock and of Sax on plant material, and of Muller and Belgovsky on Drosophila, to the effect that the manifold kinds of structural changes capable of surviving indefinitely are all caused by two distinct primary processes, succeeding one another. These are: (1) breakage of the chromonema at two or more points, followed (2) (though not until after the spermatozoon stage is passed) by two-by-two junction between the adhesive broken ends, giving a new linear order. Distant breakages, giving gross changes, were shown to result from separate individual ionizations, but nearby ones, giving minute rearrangements, to result from one and the same ionization by a spreading of its effect. The reports and demonstrations of a large series of separate investigators—Bauer, Fabergé, Demerec, Camara, Catcheside, Oliver and Belgovsky—in one way or another agreed with or led to one or more of the same conclusions, although some investigators had until then held contrary views. Further light was thrown on chromosome structure and on the changes to which it is subject, in a special evening lecture by Metz, recounting his notable findings in Sciara.

A considerable group of papers analysed the special, though not absolutely distinctive, properties of heterochromatic regions of chromosomes. In this connexion, further illustrations were given of the high breakability of these regions by Kaufmann, Camara, Prokofyeva and Sidorov, and of their somatic variability (correlated in related cells) in respect to manner of chromatin staining, manner of aggregation of chromonemata and gene functioning. It was noted that all these properties extend, although to a degree diminishing with distance, beyond the originally heterochromatic regions into regions lying near to them in the chromonema, by a kind of 'position effect' (Schultz, Prokofyeva, Panshin, Khvostova), and the important new point was brought out that the variations in staining—which, as proved by Caspersson and Schultz's studies of ultra-violet absorption spectra, fairly represent nucleic acid distribution—and the variations in gene activity are correlated with one another. Evidence was also adduced, by Prokofyeva and by Kaufmann, that small interstitial regions having some degree of heterochromaticity are scattered rather widely throughout the chromatin, and often coincide with regions that apparently originated relatively recently as duplications (which suggests that genes may become heterochromatic by a kind of denaturizing degeneration).

Analysing the mechanism of gene mutation on the basis of a great series of experiments, Timoféeff-Ressovsky brought out its causation (1) by individual atomic activations, apparently resulting from the accidental peaks of kinetic energy of thermal origin, as well as (2) by individual ionizations, resulting from radiation. The dependence on single ionizations was further strengthened by Rai-Choudhuri's finding that even radiation of intensities so low as 0·01 r./min. (a hundred times lower than the lowest previously used in such work) is so effective, ion for ion, as radiation of higher intensities. At the same time, the generality of the gene mutation effect of radiation was strengthened in another important way, by its definite extension to mammals (mice), in experiments of P. Hertwig.

* Although the Russian geneticists had withdrawn and most of the Germans had left before the time for their addresses, their abstracts had already been submitted, and in this Section the policy was followed of reading all such papers *in absentia*. They are accordingly included in this report, although only the papers of official members will be printed in the *Proceedings*. Also included here are papers given in joint meetings of this and the next Section.

In earlier work, no dependence of the frequency of the gene mutations upon the closeness of spacing of the ions within the radiation-paths could be detected, but newer work by Timoféeff-Ressovsky and his collaborators, reported at the meeting, suggested that a perceptible influence of this kind might be found by the use of the extremely closely spaced ions resulting from some neutron radiation. If so, it should be possible to estimate the 'sensitive volume' for a gene mutation, that is, the amount of contiguous space occupied by material so constituted that one ionization, occurring anywhere within it, is capable of producing some one or more of a given series of alleles. Similar work, utilizing the frequency of chromosome breakage instead of that of gene mutations, was reported by Marshak. In this connexion, however, it should be noted that if, as seems likely, only a small proportion of the ionizations occurring within the region in question actually resulted in the effect looked for, this method would tend to lose its efficacy. Moreover, we have no basis for identifying the volume or area in question with that of the gene or chromonema itself.

In addition to the seemingly simple thermal effect of van t'Hoff type, above-mentioned, there were shown—by Plough, Timoféeff-Ressovsky, Kerkis and Zuitin—to be decided increases in mutation frequency attending the abnormal physiological states of organisms subjected to temperature changes too rapid or too extreme for the organisms to adjust to them. This makes the search for special chemical influences affecting gene mutations seem more promising, despite certain negative results reported by Auerbach with carcinogenic substances. The sensitivity, as well as the intricacy, of the chemical complexes conditioning mutation was further evidenced by the strong dependence of the general mutation frequency upon the genetic complex present, as reported by Plough and by Tiniakov, and more especially by observations of Rhoades and of Harland showing certain enormous and highly specific mutational effects on particular genes, not previously known as 'mutable genes', by other particular genes and gene-combinations.

The series of papers dealing with the production of mutations by ultra-violet light showed the notable progress made in this field since the last congress. It was shown by Stadler that the curve representing the effectiveness of different wave-lengths in producing gene mutations and deficiencies in maize pollen begins at about 313 mμ and rises to a peak at 254 mμ, declining thereafter. This is suggestively similar to the absorption spectrum of nucleic acid and quite different from that of protein. Both Hollaender, working on fungus spores, and Knapp and Schreiber, on spermatozoids of Sphærocarpus, reported results substantially similar to this, although their peaks of mutational effect (as well as of directly lethal effect) were at 265 mμ, which corresponds more exactly to the absorption peak for thymonucleic acid. In Hollaender's work, however, there was also a secondary peak, at 238 mμ; and another peculiarity in his results (one suggesting differential sensitivity of different spore stages) was a falling off in the mutation frequency of surviving individuals at very high doses.

In Stadler's work, a basis was found for drawing qualitative distinctions between several different classes of radiation effects. Thus, the frequency of abortive embryos at different wave-lengths, unlike that of gene mutations and deficiencies, failed to follow the nucleic acid curve, as it showed too high frequencies for the shorter wave-lengths. While these abortive embryos may after all represent some kind of non-genetic effect, the same cannot be said of sectional rearrangements of chromosomes (translocations). Stadler found that the latter were not produced by ultra-violet light, or were produced with a markedly lower frequency than by X-rays of the same gene mutation-producing strength.

This result, which was corroborated for Drosophila sperm by experiments carried out by Muller and Mackenzie, gives some ground for supposing that ultra-violet does not act by breaking the chromosomes, and that therefore gene mutations may not consist merely of linear rearrangements of ultra-small size, involving 'intragenic' breakage and reunion. The latter idea, which is not yet actually refuted, would have tended to make the concept of the segmentation of the chromosomes into discrete 'genes' a mere matter of verbal convenience. Possibly connected with the same series of problems was Stadler's further finding that the gene mutations produced by ultra-violet are far oftener 'fractionals'—that is, confined to one of the chromatids derived from a given treated chromosome—than are those produced by X-rays.

For the first time in the history of genetics congresses a session was included on virus and protein studies in relation to the problem of the gene. A peculiar case of non-chromosomal, probably virus, 'inheritance' in Drosophila, was reported by L'Héritier and Teissier. As was brought out by McKinney, by Gowen and by Kausche, viruses, now known to be crystallizable nucleoproteins, have the distinctive combination of properties characteristic of genes, namely, mutation and (despite mutation) self-duplication, thus substantiating the concept (Muller, 1921, 1926) that viruses represent relatively free genes, and that the gene constitutes the basis of life.

An illuminating account was given by Astbury of his and other modern studies of the chemical structure of viruses and other proteins, with especial consideration of those features which might help to explain the gene's property of mutable self-duplication. He, as well as Caspersson and Schultz (who reported an increase of nucleic acid during periods of growth, both for chromosomes and for cytoplasm), directed attention to the role which nucleic acid may have in this process. The significant fact was reported by Astbury that the nucleic acid spacings are of the same magnitude as those within the protein (polypeptide) chain, a feature which would allow the nucleic acid to unite in parallel with the protein and so perhaps to serve as an intermediary in its synthesis. The paper of Mazia also was of interest in this connexion, since it showed that in salivary chromosomes the framework is not disintegrated by digestion either by pepsin or by nuclease, though it is by trypsin; hence it probably consists of protamine or histone chains, bound together laterally in some other way than by nucleic acid cross-connexions. Other chemical studies of nuclear material were reported by Gulick, which among other things cast doubt on the presence of iron in chromosomes, thus bringing their composition closer to that of the virus.

Our present knowledge of the internal structure of the tobacco mosaic virus particles, as disclosed by the pioneer X-ray diffraction studies of Bernal, Crowfoot *et al.*, was described by D. Crowfoot as well as by Astbury. It was shown that in these rods, which are 15 mμ thick and at least ten times as long, the smallest possible chemical unit—that associated with one nucleotide—must contain about fifty-four amino-acid radicals, although there may be a geometrical sub-unit as small as one eighth of this volume (that is, about 1 mμ each way). But these units (or sub-units) are grouped according to a regular pattern into larger aggregates, about 7 mμ long, and the latter in turn are grouped in a regular way to form the aggregate of high order—the virus rod itself. The globular protein insulin, as well as the fibrous proteins, all show elementary units of about the same size, but the mode of aggregation varies both with the protein and with the conditions (*p*H, amount of water, etc.) under which it is being kept. Thus this type of analysis is already bridging the gap between the structures of the chemist and those of the microbiologist and geneticist.

A series of special conferences were held on problems of the gene, presided over chiefly by J. B. S. Haldane. These were very well attended. At these 'gene conferences' many of the reports of those unable to attend were read, and many of the above and related questions concerning gene and virus structure and gene mutation were subjected to animated and searching discussion.

CYTOLOGY

By Dr. C. D. Darlington

PERHAPS the most significant feature of the cytological discussions was the difficulty of separating them, except in an arbitrary way, from the discussions of experimental breeding. This was due to three general trends. First there was an increasing use of the direct study of meiosis as a basic of genetic prediction and as a means of testing the reproductive methods of particular species. The work of White and Koller with sex chromosomes and of Huskins and Newcombe with the relations of chromatids at chiasmata were examples of the one, the studies of Levan on Allium, of Cleland on Œnothera, and of Janaki on Saccharum were examples of the other.

The second trend was the increasing application

of experimental methods to cytology, both to solve problems that are of immediate cytological interest and to produce results of practical importance in breeding. The different kinds of upset induced in cell-division are of interest in both ways. The diplochromosomes produced by Barber's heat treatment represent the mode of action of colchicine described by several workers in giving rise to polyploids. The third trend was the increasing linkage of Drosophila genetics with a minute study of salivary chromosomes, so that we found leading geneticists in America and England, like Demerec and Muller, offering papers embodying accounts of the breakage and reunion of chromosomes related to the direct observations of cytological workers like Kaufmann and Bauer.

This last development showed its widest bearings in the kind of population study described by Dobzhansky. The interlocking action of gene change and chromosome change now discovered in field genetics is evidently making it possible to bring the scheme of variation in Drosophila into the closest relationship with plant cytology. It gives the whole body of genetics and cytology a unity which is enabling them to be used as a joint tool of evolutionary research.

A word should be said of the technical side of cytology. The great advances of recent years were represented by an extensive microscope demonstration of chromosomes of Drosophila, Zea, Osmunda, Paris, Trillium, of various Orthoptera, and of Mammalia including man. A show of photomicrographic lantern slides brought home these exhibits to a larger audience and made it possible to compare the merits of different new methods of treatment.

A combined gene and chromosome session opened by Dr. W. T. Astbury was devoted to protein and virus studies in relation to the gene. It showed the results of applying new technical methods in protein and virus chemistry. It also showed that these, combined with the study of X-ray mutations on the genetical side and the use of ultra-violet photography and microchemical tests on the cytological side are producing a practical convergence of biology and the physical sciences, a convergence that will probably mark the beginning of a new epoch.

PHYSIOLOGICAL GENETICS

By Dr. C. H. Waddington

ONE of the most active branches of genetics at the present time is the study of the ways in which genes affect developmental processes, and the section devoted to physiological genetics had a full and interesting programme. The problem of genic action is so complex and many sided that very many different methods of approach are possible, and examples of most of these can be found in the papers presented at the Congress.

The embryological approach was well exemplified in a paper by Landauer, in which he reviewed the correlated effects on different organs which are found both in fortuitous teratological specimens and also in abnormalities which are known to be dependent on genes. He suggested that many of these phenomena can be explained by the hypothesis of a general deleterious effect, often on the growth-rate, acting at a period which is critical for a certain set of developmental processes. A general embryological approach of a rather different kind was presented by Waddington, who discussed the relation of genes to developmental processes of the kind exemplified by the organizer reaction.

The importance of nuclear factors in particular steps of differentiation was analysed in more detail by Baltzer, who gave a summary of his well-known and important work on bastard merogons, in which an enucleated egg of one species of newt is fertilized by a sperm of a different species. He showed that some tissues are able to develop to late embryonic stages, while others die presumably owing to disharmonies of nucleus and cytoplasm during particular processes of differentiation; still other tissues, such as some of the anterior mesoderm, while able to live, lose their normal power of inducing other organs—in this instance the balancers and gills. Similar studies of the importance of particular elements in the nucleus were reported by Poulson in his studies of the abnormalities produced by total absence of

certain genes (homozygous deficiencies) on the early development of Drosophila.

Several reports dealt with gene effects on processes which are chemically more or less defined. Thus we had further chapters in the important and rapidly developing researches of Price, Lawrence and others on flower pigments, and Beadle, Ephrussi and others on Drosophila eye colours. Perhaps the most important new contribution in this field was a fresh study by Sewall Wright of guinea pig coat colours, which he dealt with in a preliminary way many years ago. He was now able to suggest a scheme for the relations of the numerous genes which are known, and to present a mathematical theory of their quantitative interactions.

Quite a different method of approach to the same problem was reported by Schultz and Caspersson, who, by studying the chromosome itself, obtained data which allow of some speculation as to the chemical changes occurring under the immediate influence of genes. Owing to their strong absorption in the middle ultra-violet, the distribution and changes of the substances belonging to the nucleotide group can be followed in the living cell by spectrophotometric methods elaborated by Caspersson. It is found that in the nucleus the nucleic acids seem to be indispensable for the development of chromosomes, and that they are synthesized mainly in earliest prophase just before the chromosomes split. Schultz studied translocations of parts of the heterochromatic regions of the chromosomes, which are rich in nucleic acid, into normal euchromatic regions in Drosophila. In certain of these translocations the adult flies show variegation for characters affected by genes near the position of the break in the chromosome, as though frequent mutations of the genes had occurred in late stages of development. Schultz showed that this variegation is correlated with cytological effects in the salivary chromosome bands corresponding to the variegated genes; these effects ranged from appearance of excess nucleic acid to the assumption of a heterochromatic character and finally apparent disappearance. It is suggested that the appearance of excess nucleic acid is correlated with an inactivation of the gene as a developmental agent. The nucleic acid metabolism can be followed somewhat further, since it is found that the presence of extra heterochromatic material (for example, supernumerary *Y*-chromosomes) affects both the degree of variegation, the cytological correlates of variegation mentioned above, and also the nucleic acid content of the cytoplasm. The different types of nucleic acid occurring in chromosomes, nucleolus and cytoplasm can be determined spectroscopically and suggestions made as to their functional relations with the fundamental processes of gene action and gene reduplication.

It is possible, as Schultz suggests, that we may in this way obtain some insight into the changes of gene activity in different chromosome regions in the different tissues, which may provide a mechanism for the primary differentiation of the nuclei in development.

ANIMAL BREEDING IN THE LIGHT OF GENETICS

By Dr. J. E. Nichols

THE opening session was devoted to general considerations of animal genetics. H. C. McPhee described the United States Department of Agriculture's long-term inbreeding projects with pigs, sheep, and poultry, and the emphasis now being laid upon measuring the more complex physiological characters; and in reviewing the work at Wiad, Sweden, G. Bonnier mentioned the economy in numbers of experimental animals made possible by the use of monozygotic twins, and the similarity to plant breeding techniques now being obtained with poultry, where the mixed sperm from many males can be used in artificial insemination. W. K. Hirschfeld and G. M. van der Plank struck notes for many succeeding speakers in directing attention to the distinction between frugal and less frugal breeds and families relative to production, and to the need of precise studies on differential demands upon the components of a ration. Their advocacy of the progeny test was pressed further by A. L. Hagedoorn, who suggests restricting to *élite*

'nuclei' of breeding stock the function to be sole progenitors of their kind.

The section got into its stride of discussion on August 24 in an all-day session on live-stock improvement in tropical and relatively low nutritional plane conditions. J. H. R. Bisschop gave a comprehensive account of the interesting zootechnical studies on Afrikaner, imported, and grade cattle being conducted in South Africa, with the objectives of defining a type and performance suited to semi-arid conditions and of assessing the degeneration of the pure imported types therein. Using the Australian Merino sheep as an example, J. E. Nichols discussed the practical difficulties of adjusting type to environment when artificial selection is heaviest in more favoured and natural selection in poorer conditions, where commercial production is expected. A. O. Rhoad described the experimental determination of adaptability of cattle to unfavourable conditions in America by means of body temperature reactions, and revealed genetic differences in respect of physiological characters; while Manresa and his collaborators demonstrated significant differences in the hæmoglobin and other constituents of the blood in cattle in relation to atmospheric temperatures (and thereby to adaptability to the local environment) in the Philippines. The economic and social backgrounds of breeding problems in the animal industries in countries from the Gold Coast to Madras were presented in several communications, and R. B. Kelley lodged a strong claim for the importance of ecological and economic studies as prerequisite surveys to constructive breeding policies in tropical Australia. Later, G. Pontecorvo stressed the influence of agricultural conditions on policies of selection in beef and draft cattle in Tuscany.

The use of artificial insemination as a rational technique in animal breeding was discussed in a special session at which were described the methods employed, and their accompanying problems, in Italy, the United States, Rumania, Kenya, and at Lwow. The necessity of adequate criteria of sperm efficiency was strongly stressed by J. Edwards and A. Walton in presenting an account of recent investigations at Cambridge in which the respiration rate of sperm has taken a prominent and promising position.

Statistical safeguards and interpretations in genetical experiments with animals and in the analysis of records of performance and progeny tests were discussed notably by F. Yates and J. L. Lush, not only in formal papers, but also in relation to other contributions, especially those on the inheritance of milk yield. This problem, of great practical importance, stimulated one of the most effective discussions of the section, in which particular attention was given to the question of persistency in lactation. The lability of the several phases of a lactation in response to environmental influences of nutrition, management, etc., leads to difficulties in evaluation of records, but emphasizes the need for detailed analysis as well as ultimate resolution in terms of the physiological processes affecting the component parts of the curve.

In other sessions lethal factors and defects in large animals and genetical characters in small animals were discussed; F. W. Dry presented a case of linkage between horns and abundance of halo hairs in New Zealand Romney sheep, and R. C. Bamber an interesting instance of the operation of a time factor in the inheritance of white spotting in cats.

Breed differences and the recognition of the physiological substrata received further prominence in the session on poultry genetics when F. B. Hutt presented evidence of differential reactions and performances, A. W. Greenwood advanced indications of a genetical control of egg-laying persistency, and A. Ghigi's contribution on cerebral hernia in the fowl evoked discussion on the relationships of skull form, 'crest', and hernia.

Again, in the sessions concerned with nutrition and genetics, and with pig breeding, the same fundamental approach was manifested; as in the demonstration by C. P. McMeekan and J. Hammond that the plane of nutrition exerts a profound effect upon not only general form but also the growth components so that the direction, as well as the possibility, of selection is influenced by environmental thresholds. That this aspect of the problem of livestock improvement deserves further scientifically determined discrimination at all stages of growth and in regard to practical breeding policies was emphasized by H. P. Donald and by H. R. Davidson.

It may be said, in fact, that the central theme throughout the proceedings of this section was the evaluation of genetic differences and responses to environmental conditions in relation to the requirements of practical husbandry.

PLANT BREEDING IN THE LIGHT OF GENETICS

By Dr. K. Mather

THE following conclusions may be drawn from the section of plant breeding in the light of genetics: first, that genetics and cytology can afford valuable assistance to the plant breeder, and secondly, that the geneticist needs a better understanding of the problems of plant breeding, and the breeder of the possibilities of genetical research, before really fruitful collaboration will be achieved.

The breeder requires, for example, detailed information about the mode of reproduction and the cytological behaviour of his material. Cytology and genetics can and do give him such information. But he also needs very detailed knowledge of the inheritance of quantitative characters, and this the geneticist cannot at present supply. It is highly significant that in horticultural breeding, where genetics and cytology have most fully proved their value to breeding programmes, the geneticist is also frequently a breeder. The breeding problems can in such cases be attacked immediately with the full resources of the genetics, and on the other hand, the value of any new genetical technique for breeding work is immediately appreciated. As a case in point, Crane and Thomas have encountered the necessity for determining the mode of reproduction of Rubus species, and have been able to obtain the necessary information by a series of simple genetical and cytological observations. There is also collaboration between breeders and geneticists interested in maize, and for the past fifteen years maize breeding methods have been developed at a rate far exceeding that found in any other cereal crop, as described by Lindstrom, Singleton and Jenkins. The problems of the root-crop breeder closely parallel those encountered in the case of maize, and in overcoming them Rasmusson adopts a similar technique based on like genetical experience.

It is in the field of self-fertilizing cereals that there has been least collaboration, and it is here that opinion is most sharply divided on the question of the practical value of genetical work. Cytology has provided essential information about the causes of sterility in wheat species crosses and in Triticum-Agropyron crosses, but it is clear that the real need of the cereal breeder is guidance in his varietal crossing and selection programmes. This guidance can only be given when more genetical research has been done on inheritance in quantitative characters.

Perhaps the most difficult and least developed aspect of plant breeding is the production of what are essentially new species of crop plants by hybridization and polyploidy. The discovery of the action of colchicine in bringing about chromosome doubling has given a stimulus to research in this field, as shown by the number of papers on the subject. It is, however, too early to assess accurately the practical possibilities of colchicine treatment. In this connexion, also, the study of the origin of our present cultivated plants is of prime importance in indicating how such new forms might be made. Mangelsdorf's analysis of the origin of maize materially adds to our knowledge in this direction, besides affording another example of how genetical analysis can be used in the solution of an evolutionary problem.

All breeding work involves variety trials, and both these and the development and use of the theory of quantitative characters will require rather complex statistical analysis. The use of statistics in plant breeding was the subject of a joint meeting of this and the statistics section opened by Yates. It was apparent that the full benefit of statistics, as of genetics, has not yet been realized in plant breeding.

Though the task of organizing genetics, cytology and statistics in the service of plant breeding is unquestionably difficult, the Edinburgh meetings, especially that of Frankel's committee of plant breeders, have been of service in showing not only what has been done but also where the difficulties are to be found. Further meetings of the same kind should be of even greater value.

HUMAN GENETICS

By Prof. R. Ruggles Gates, F.R.S.

HUMAN genetics was well represented at the Congress. Abstracts of a large number of papers were prepared, but like other sections their presentation was somewhat deranged by the approach of war. At different sessions the section discussed such topics as mental inheritance, feeble-mindedness, blood groups, statistical methods in human genetics, selection in human populations, twinning, normal and abnormal human characters.

F. Lenz showed that the twin method and the correlation method may give different results as regards the relative shares of heredity and environment in the formation of a character. Dr. R. J. A. Berry presented the results of a study of mental defect in 163 families with parents of normal mentality and 202 families in which the parents were mentally defective, insane or of very low mentality. Mental defectives were twice as frequent in the second group. The problem was regarded as one of the inheritance, not of mental states but of normal standards of growth. Dr. Brügger agreed that the majority of mental defectives show only retarded mental development, and concluded from the investigation of 2,380 sibs that there is a unified recessive inheritance, feeble-mindedness and imbecility generally appearing together.

Dr. Fraser Roberts pointed out that most defectives fall at the minus end of the normal continuous series and he believes there is multifactor inheritance, the low-grade defectives forming a very heterogeneous group. He concludes that there are a number of genes, any pair of which can determine idiocy or imbecility, abnormal susceptibility to non-genetic influences frequently being present. From a study of 3,400 school children by intelligence tests he concludes that normal intelligence is also graded and very largely determined by multifactor inheritance.

D. K. Henderson recognized a hereditary basis for the manic-depressive and schizophrenic states and emphasized that a eugenic programme must be largely educational. Helgi Thomasson, on the other hand, from a nine years study of manic-depressives in Iceland, was doubtful about the inheritance element. He diagnosed 859 cases of manic-depressive psychosis, only 15 per cent of whom were treated in hospital. Probably his criteria of diagnosis differed from those of others, and perhaps the general climatic conditions in high latitudes may also account for the high incidence. Dr. F. J. Kallmann emphasized that the practical goal of human genetics is the determination of the various physiological, constitutional and dispositional factors governing the phenotypical manifestation of hereditary predispositions and the description of their structural equivalents in proper morphological terms. From a study of 500 pairs of schizophrenic twins and their families, he concludes that the schizophrenic genotype is specific, autosomal and probably single-recessive. Its manifestation is inhibited in about one quarter of the homozygotic taint-carriers by the aid of a strong constitutional resistance or by the lack of furthering dispositional factors.

In a discussion of rare psychological defects in a population, G. Dahlberg concluded that the effect of selection on its incidence is very small, that the effect of prevention of cousin marriage is also small, but that the breaking up of isolates in the population is most important.

Various workers have shown that an injection of cardiazol produces epileptic spasms in animals and man, but a hereditary epileptic will have fits after a smaller dose than a non-hereditary epileptic or a non-epileptic. Hans Nachtsheim finds that a strain of white Vienna rabbits has a gene, X, for leucism and an allele Xe which causes increased liability to spasms, X being dominant over Xe. Among 250 animals given minimal doses of cardiazol, 83 per cent of the homozygous $XeXe$ rabbits but only 3 per cent of normal controls react with spasms.

Pick's disease was studied by J. Sanders in a family with sixteen affected members. The symptoms begin at 40–50 years of age, so that early diagnosis is important. The inheritance is dominant, and it was found that persons who gave queer answers in the ink blot tests developed the disease twelve to eighteen months afterwards.

In a study of twenty-nine families showing tooth deficiency, Barbara Burks found evidence of linkage with hair colour. D. J. Finney also obtained statistical evidence of linkage between allergy and the *ABO* blood groups; while Munro, Penrose and Taylor, from analysis of twenty-five sibships, found an indication of linkage between the blood groups and phenylketonuria.

As regards disorders, R. C. Robb reported on 100,000 hospital patients, and D. P. Murphy on 935 malformed children studied in relation to birth order, sibs, maternal age, reproductive rate, etc. H. Madissoon cited cases of absence of kidneys (in the fœtus) conditioned by heredity. D. Ferriman found that oxycephaly and acrocephalosyndactyly are dominant conditions, probably allelomorphic, and that a third allele may be acholuric jaundice. Race, Taylor and Vaughan showed that a latent form of the latter disease can be demonstrated by investigation of the blood. Dr. I. Lundholm showed that hypochromic anæmia, which is common in women in Sweden, is conditioned by a dominant gene which prevents the normal absorption of iron through the digestive tract.

J. B. S. Haldane pointed out that natural selection in man may act through survival, sexual selection or reproductive selection (fertility), and that in theory four types of selective process can be distinguished, involving slow or rapid selection of genes, selection of heterozygotes or elimination of rare mutants.

P. J. Waardenburg showed that the *X*-chromosomal eye defects, dystrophia retinæ pigmentosa and extraocular nystagmus can be inherited as dominant or recessive sex-linked or dominant or recessive autosomal characters.

GENETICS IN RELATION TO EVOLUTION AND SYSTEMATICS

By Dr. W. B. Turrill

THE Organizing Committee of the Congress, at the suggestion of the Association for the Study of Systematics in Relation to General Biology, arranged for a special section to be concerned with the wider aspects of genetical research. In spite of the numerous difficulties caused by the international situation both in arranging and carrying out the programme, the results not only justified the attempt but showed the desirability of making a general rule to include in specialist biological congresses a section devoted to overlaps of the special subject with other branches of biology.

The programme of the section was so arranged that papers were grouped under the following general titles: Hybridization, Comparative Genetics and Evolution, Micro-evolution, Experimental and Wild Populations, and Polyploidy and Reproductive Mechanisms. In the plenary session of the section, Th. Dobzhansky dealt with the genetic structure of natural populations. He urged that "according to the genetic theory the pressure of the evolutionary factors, such as mutation, selection, isolation, and migration is constant and unrelenting. A living species can hardly remain static for any length of time. It is a task of the investigator to observe evolutionary changes not only *post factum* but also in *statu nascendi*, in nature as well as under laboratory conditions". There is a hidden field of variation, detectable not through observations on the phenotype but only by genetic and cytological means, and this must engage the attention of students of evolutionary mechanisms. The main part of his paper dealt with *Drosophila pseudo-obscura*, and it was shown that this is a dynamic species of local colonies which can pursue, within certain limits, independent evolutionary courses. Only secondarily through migration and selection of superior genotypes formed in such colonies can the texture of the species as a whole become gradually altered.

G. Tischler, under the (translated) title the "Role of Chromosomal Race Differences in Systematics and Plant Geography", stated that at least 400 wild cœnospecies of Angiosperms are known which contain races with chromosomal differences. Many species become capable of surviving in a climatically unfavourable environment through polyploidy, but within these species many type plants have

remained diploid. Numerous species have become weeds with a world-wide distribution, but their diploid races have only a local significance. Allopolyploids may inhabit wider areas than either parent. Polyploids may develop a perennial habit, apomixis, or seasonal dimorphism.

J. S. Huxley, in a general paper on "Systematics in Relation to Genetics", gave a valuable summary of the tendencies of modern taxonomy, illustrated by many examples. He showed that the progress of taxonomy itself, and its contacts with other branches of biology, are converting it into the basis of the study of evolution in action. In the first place, cytogenetic analysis is shedding light on particular taxonomic problems; secondly, taxonomic advance is suggesting important questions for experimental analysis; and thirdly, a combination of all lines of approach is increasing both the scope and the precision of the general principles underlying taxonomy and making it possible to forecast the course of differentiation and evolution in different kinds of taxonomic groups. It is not only cytology and classical genetics which are needed to co-operate with taxonomy, but also ecology and embryology are equally essential.

W. B. Turrill considered "Taxonomy and Cytogenetics in Plants" and pleaded for close co-operation between taxonomists and cytogeneticists. He illustrated the most desirable lines for such co-operation by examples of problems of mutual interest under the following headings: classifications of characters, degree of correlation of characters, constitution of taxonomic groups, the study of polymorphic groups, geographical and ecological problems, hybridization in Nature and experiment, problems of apomixis, problems of phylogeny, and general suggestions.

S. C. Harland read a paper under the title "Genetical Studies in the Genus Gossypium and their relation to Evolutionary and Taxonomic Problems". Within the widespread species of this genus in both the Old and New Worlds he traced the consequences of isolation for several millions of years. Species crossing and the study of their cytology in Gossypium has led to the accurate delimitation of the genus, has shown that species may be regarded as systems of modifiers, has revealed the taxonomic position of species in relation to other species, and has proved that species intercrossing results in the disintegration of the co-ordinated modifier systems possessed by each; it has shown that geographical isolation causes profound genic change, has indicated that genes may become mutable when transferred to the genetical background of other species, and has suggested that the number of alleles at a given locus differing only slightly in their reaction with the genetical background is probably large.

It is impossible in this article to deal with contributions to the ordinary meetings of the section except in a very brief and most generalized manner. The recognition of much more hybridization in the wild amongst animals than has usually been admitted by zoologists was stressed in several papers. The importance of population studies in throwing light upon the actual mechanism in evolution was also emphasized. The geographical distribution of 'races' in both animals and plants is obviously receiving increased attention and proving a connexion 'between genes and geography'. The wide occurrence of polyploidy and apomixis in plants is being shown to be one of the causes which make it difficult to accept the species as a clear-cut taxonomic unit.

GENETICAL ASPECTS OF GROWTH, NORMAL AND ABNORMAL

By Dr. A. Haddow

THE fundamentals of this subject were outlined in a paper by E. B. Ford, who demonstrated how growth may be determined genetically by the most diverse means. Thus it may be under the control of a single factor-pair, or very numerous genes, approximately equal in effect, may co-operate. Again, while the genetic situation can influence cell-size or cell-division directly, the effect on growth is frequently indirect. For example, genes controlling the endocrine glands

will modify total body size in mammals, as in recessive dwarfing in mice due to a factor-pair affecting the development of the anterior pituitary. Dr. Ford further discussed (1) the production by heterosis of increased size in the offspring of a wide cross, and (2) excess or reduction in hybrid size caused by mal-adjustment of the gene-complex. Similar considerations apply to differentiation, as in the case of a sex-linked factor producing dominant black-spotting in Platypoecilus and tumour formation in the hybrid between this and another form (Xiphophorus).

In a discussion of dominance in spontaneous cancer, P. A. Gorer dealt with the genetic basis of the inheritance of lung cancer in mice, mentioning evidence that the appearance of lung tumours is conditioned by three or four genes with additive effect, the degree of dominance thus depending upon the number introduced by the high-cancer parent. In those cases where the onset of tumours is delayed in the heterozygote, he regarded it as probably incorrect to speak of a change of dominance with age (Bernstein), since it is likely that the reactions preceding tumour emergence simply occur more slowly in the heterozygote.

Considerable interest centred round the interplay of genetic and environmental factors in the origin of different cancers. According to N. Dobrovolskaia-Zavadskaia, the failure of external carcinogenic agents to produce mammary cancer in mice, even in strains of high susceptibility, indicates that the onset of such tumours is almost entirely dependent on genetic constitution. On the contrary, sarcomata and squamous-cell epitheliomata appear to depend pre-eminently on environmental influences, a view confirmed by W. F. Dunning and M. R. Curtis when they reported that variation in the concentration of a chemical carcinogen is much more effective in influencing the probability of malignant change than is the genetic nature of the host. In another paper on the effect of genetic constitution in determining the response to carcinogenic agents, G. M. Bonser described the gradation of tumour-response by male mice to œstrogens as reflecting the ability of the females to develop spontaneous mammary tumours, although when castrated females of high-cancer strains were tested with œstrogens, their ability to develop mammary cancer was reduced.

In a communication dealing with spontaneous and induced tumours in eight inbred strains of mice, H. B. Andervont stressed (1) the correlation between the susceptibilities to spontaneous and to induced pulmonary tumours, and (2) the absence of any correlation between susceptibility to the induction of subcutaneous tumours by carcinogenic hydrocarbons and susceptibility to spontaneous breast tumours.

Other contributors included G. W. Woolley on reduction in the incidence of mammary tumours in female mice in parabiosis with males, and H. J. Bagg on his method for early selection in mice and rats, by forced breeding coupled with the prevention of suckling, of those individuals constitutionally prone to the development of breast cancer. W. Cramer and E. S. Horning described the association in inbred strains of mice between brown degeneration of the adrenal and the incidence of mammary cancer, although L. Kreyberg found no difference in the occurrence of brown degeneration in two homozygous lines, one manifesting a high and the other a low yield of spontaneous mammary tumours.

R. J. Ludford discussed somatic mutation in relation to growth, while P. A. Gorer also examined the choice between this concept and "anomalous differentiation" in the origin of tumours. C. Auerbach reported work on various carcinogenic hydrocarbons in respect of their influence on mutation in *Drosophila melanogaster*. None of the compounds used produced any increase in mutation-rate, a result which could not be ascribed to insufficient substance, although it might conceivably be attributed to factors such as time allowed for action or penetration to the tissues.

PRINTED IN GREAT BRITAIN BY FISHER KNIGHT AND CO., LTD., ST. ALBANS.

NEWS AND VIEWS

Royal Society Medal Awards

THE following awards of medals have been made by the president and council of the Royal Society: Copley Medal to Prof. T. H. Morgan, For.Mem.R.S., director of the William G. Kerckhoff Laboratories, California Institute of Technology, for his establishment of the modern science of genetics, which has revolutionized our understanding, not only of heredity, but of the mechanism and nature of evolution; Davy Medal to Prof. J. W. McBain, F.R.S., professor of chemistry in Stanford University, for his distinguished work in the study of colloidal electrolytes, for providing the elements of the guiding theory, and for developing the subject; Hughes Medal to Prof. G. P. Thomson, F.R.S., professor of physics in the Imperial College of Science and Technology, London, for his important discoveries in connexion with the diffraction of electrons by matter.

Engineers in War-time

THAT a special degree of responsibility falls on those called to high office in a professional capacity in time of war was apparent from the presidential address of Sir Clement Hindley to the Institution of Civil Engineers. Instead of devoting himself, as he had intended, to recounting the cultural history and development of the Institution, he found it more appropriate to put before the members the picture he had in mind of the duties now to be taken up by the Institution as a corporate body, and by its members as individuals. The regular forms of its activities being very largely curtailed by the exigencies of war conditions, its first duty lies in the maintenance of high standards, both educational and practical, for the admission of members. This involves an active interest in the education and training of young engineers and, as a matter of immediate concern, in conjunction with the colleges, the adjustment of curricula to war-time conditions. On the Institution, too, is placed the responsibility of seeing that studies are pushed on as far as possible before military service has to be undertaken, and that those with technical training are employed in suitable units. In all this there is the ultimate fact of importance that when the period of reconstruction is reached, Great Britain will need a well-trained and well-equipped body of young engineers.

THE second duty of the Institution is that falling on individual members to contribute their experience and knowledge to the common stock of the profession, in which the part of the Institution will be to publish in the *Journal* such contributions and the correspondence to which they give rise. The third and main function to be conserved is that of giving continued support to those scientific organizations which have undertaken research and investigation for the Institution. While certain portions of this work have to be suspended, the Research Committee remains in being in order to deal with problems suggested, and the resources of the Institution are held available for any work the Government may consider can best be carried out by its members. Sir Clement's final remarks may be quoted as a message to all engaged in the pursuit of science and its application: "We may be sure that when we have passed through the present ordeals, and have achieved the victory for freedom for which we are now fighting, there will be unimagined opportunities for applying for the benefit of the human race those advances in science which are even now taking place under the stimulus of war. It is necessary for all engineers to continue to keep abreast of developments in engineering science and practice, and so to fit themselves for this great work of the future."

Fuel Industry in Great Britain

COLONEL W. A. BRISTOW, on his installation as president of the Fuel Luncheon Club, spoke on modern fuel problems. After indicating the cost in foreign exchange of refined oil products and other material such as carbide, silicides, etc., which can be made in Great Britain, he mentioned other products capable of synthesis more or less directly from coal. From the products of the carbonization and gasification of coal he indicated that a great range of chemical products can be made, and, in view of Great Britain's adverse balance of trade, must be made. The obstacle, he said, is not lack of skill, knowledge or courage, but an absence of planning at the centre. Another deterrent is the financial system by which the 'financial whipcrackers' controlling public companies insist on immediate dividends and frown on efforts made in the national interest. He thinks the State should establish a 'Commercial Research Force' not merely for pure research but also to operate plants of capacity and bring processes to fruition. If these ideas are vitally important, it is only logical that the citizen should make his due contribution. There is another reason why an early start should be made in this direction. An effort should be made to prepare for creative work for the young men who return from the war. After the last war, the coal industry passed through tragic years. Moreover, none was more severely hit than the technicians left redundant by the cessation of munition manufacture. This time we should not leave the fate of returning armies to luck, but safeguard the future of the coal, oil and allied industries.

Projected Antarctic Expedition

A NOVEL feature of the new antarctic expedition which Admiral R. E. Byrd proposes to lead from the United States to the Ross Sea area is the snow cruiser which, according to Science Service, has been designed

by Dr. T. C. Poulter of the Armour Institute of Technology. This mobile base is to be 55 ft. long and will travel on wheels 10 ft. in diameter. Propelled by petrol, it will have a cruising speed of twelve miles per hour and a top speed, on favourable surfaces, of twenty-five miles. Its range of action should be about five thousand miles. There are quarters for four men, a control cabin, engine room, machine shop, galley and laboratory. Supplies for a year can be carried. The scientific equipment of the snow cruiser includes seismic sounding outfit, gravimeter, and dip circle as well as survey instruments. The builder claims that this mobile base will allow more work to be done in one season than other expeditions have been enabled to do in several years. Its weight is not given but must be considerable, so that its range of movement will clearly depend much on surface conditions, which are always a deciding factor in any form of antarctic travel.

Arrival of the Reincarnated Buddha at Lhasa

The veil of secrecy which for so long hid the religious life and ceremonial of the sacred city of Lhasa from European eyes may be said to have been lifted finally by the account of an eye-witness, accompanied by photographs, of the arrival in that city of the new Dalai Lama, the four-year-old child in whom, according to Tibetan belief, has been re-incarnated the living Buddha. The story is told in an article which is contributed to *The Times* of November 4 by a special correspondent. Although the essential features of the installation of a living Buddha reincarnated in the person of a small child destined to become a Grand Lama were reported by the Abbé Huc, who travelled in Tibet in 1844–46, it was on hearsay only, as the Dalai Lama of that day had already attained the age of nine years. The present account is fully confirmatory of Huc, but with much added detail. On October 7 the new Dalai Lama was met by the Regent at Rigya, two miles east of Lhasa, where he had rested for two nights, and was escorted in procession to the Peacock tent, which had been erected in the centre of a triple-line, square enclosure. There he was seated on a throne, covered with white silk and fronted with the emblem of the double thunderbolt, to receive the homage and offerings of scarves from the officials, headed by the Regent, and representatives of British, Nepalese, Chinese, and of the Lhasa Moslems, who filed before him, receiving his blessing from either both hands, one hand, or a tassel pendant from a silver rod. At the close of this ceremony, which lasted for about an hour, tea was brought for the Dalai Lama in a golden teapot, of which he partook from a jade cup after it had been tasted by a household official.

On the following day the Dalai Lama entered Lhasa, the procession passing through the streets of the city to the sacred residence, the route, as on the preceding day, being lined with crowds of reverent spectators, monks and others, holding banners and auspicious emblems. One of the more interesting incidents recorded took place when, as the yellow palanquin in which rode the Dalai Lama, forming the centre of the procession, reached the entrance of a temple, it was met by the Oracle of Nechung in a state of possession. A god who acts as the guardian of religion is said to enter into him, and when he is so possessed he dances with convulsive movements, berding his body quickly to the ground, forwards and backwards. He wore a high headdress of white plumes over a golden crown, and brandished a sword and a bow. Similar devil-dances are characteristic of Tibetan Buddhism, more especially in the eastern parts of the country, where primitive animistic forms of belief survive in conjunction with the more orthodox ritual. On this occasion the Oracle, described as a "terrible figure", rushed to the Dalai Lama's palanquin, and thrust in his head so that the spirit within him could do reverence. The young Dalai Lama, it is said, was quite unperturbed.

Pacific Entomological Survey

Judging from correspondence which has recently appeared in *Science*, some misunderstanding as to the purpose and position of the Pacific Entomological Survey has arisen. A brief statement relating to the Survey appeared in Nature of January 29, 1938, p. 196. Mr. E. P. Mumford, director of the Survey, in connexion with the Hope Department of Entomology, University Museum, Oxford, has been for some years working out the collections with the co-operation of specialists in all parts of the world. More than two hundred papers have already been submitted for publication in Hawaii and elsewhere. It is important to recognize that the work at Oxford was made possible by grants from the Leverhulme Trustees and the British Museum (Natural History); the name "Pacific Entomological Survey" was used to maintain the continuity of the work, and will not be used in connexion with the present investigations associated officially with Oxford. The only object in view is to obtain, and make known, facts which will help in elucidating the problems of the Pacific Islands; the Marquesan collections and certain other material now under the charge of Mr. Mumford will be deposited in the Bernice P. Bishop Museum, Honolulu, when the final results have been obtained. To further this end the Hope Department of Entomology of the University of Oxford, by means of grants from the University for five years from October 1938, from the Royal Society and the British Association, and from private benefactors, is obtaining from sundry little-known islands in the Pacific, new collections which it is hoped will aid in elucidating problems revealed by the Marquesan work that Mr. Mumford has been completing at Oxford.

Ancient Tests for Pregnancy

In a recent paper (*Proc. Roy. Soc. Med.*, **32**, 1527; 1939) on this subject, Dr. H. P. Bayon showed that the existing translations of Egyptian papyri revealed directions for the performance of several tests for pregnancy; some of the tests seemed superstitious,

others were based on signs and symptoms, and a few could be described in modern terminology as "hormonal germination tests made with pregnancy urine". Similar tests for pregnancy, fertility and prognostication of sex are to be found in the Hippocratic writings, their survival for more than a thousand years indicating that there was some connexion between Egyptian and Greek medicine. These tests can also be traced in various medieval authors, such as Moscius, Trotula, Michel Scot, and Albertus Magnus, though they were modified in substance and method. At the end of the sixteenth century they began to be distrusted, though their practice has been recommended even in recent popular works. Dr. Bayon maintains that the original Egyptian test for pregnancy and its modifications, though seemingly absurd in theory and certainly erroneous in practice, represent the first diagnostic tests on record, while their employment throughout the Middle Ages and later indicates a persistent effort to apply biological experimentation to the needs of medicine. The Egyptian test was also a striking example of instinctive anticipation, which proved that in the development of medicine, intuition preceded practice, and was followed by understanding, which culminated in reasoned and demonstrable knowledge.

Science and Animal Welfare

As was noted under the above heading in NATURE of October 22, 1938, a committee was formed by U F A W (The Universities' Federation for Animal Welfare) in an attempt to bring scientific reasoning to some of the outstanding problems concerned with the welfare of animals, and a short résumé of the proposed functions of the committee was given. It is now possible to review the progress of the first year, which has been distinctly encouraging. In connexion with rabbit control, a grant was made towards the costs of research upon ecological aspects of the problem, which is being carried out at the Bureau of Animal Population, Oxford. The Prevention of Damage by Rabbits Act was promoted by U F A W. On Skokholm Island, off the Pembrokeshire coast, the Federation has participated in the attempt to carry out a wholesale cyanide fumigation of the warrens, and it is intended, if possible, to complete the eradication of the rabbits this winter and so render the island suitable for farming. Another area eradication experiment is being supported in Cornwall.

THE problem of anæsthetics for animals has received considerable study. It is felt that the Animals Anæsthetics Act of 1919 is in need of careful revision, and the National Veterinary Medical Association has agreed to appoint a committee of experts to review the whole position of anæsthesia in animals, and to make recommendations for the drafting of a new bill. Animal euthanasia has also been studied; one suggestion which is being discussed concerns the possible use of drugs which, although potent narcotics, have not been marketed for clinical use on account of their high toxicity or narrow therapeutic margin. While the war will almost certainly lead to a great diminution in the trading of pet animals, every effort is being made to provide, by educational means and otherwise, for an improvement in the care of such animals before and after purchase. The use of the electric goad for droving has been considered, and field tests are being carried out at an agricultural college to determine its efficacy. All who are interested in the work of the committee, are asked to communicate with the honorary secretary, A. N. Worden, at the Federation's headquarters, Gordon House, 29 Gordon Square, London, W.C.1.

Communications on Spectrochemical Analysis

OWING to the war, the publication of papers in the English language in *Spectrochemica Acta* is no longer practicable and Mr. F. Twyman, formerly English editor of the journal, has put forward a suggestion that there be an agreed single medium for the publication of such papers in England. Briefly, the proposal is that papers, articles, and notes on spectrochemical analysis should be sent to the *Journal of the Society of Chemical Industry*, and that if the communication deals with some special subject such as an application to botany, soil analysis, mineralogy, etc., the author should at the same time communicate to his own specialist society an abstract or companion paper dealing particularly with the application, while for details of the apparatus and spectrographic method reference would be made to the *Journal of the Society of Chemical Industry*. Should the 'specialist' portion of the paper be of preponderating interest, the main paper would naturally be submitted to the specialist journal, and an abstract or companion paper sent to the *Journal of the Society of Chemical Industry*. Manuscripts for the Society of Chemical Industry, which should in all cases be prefaced by a short introductory statement setting out in simple language the objects of the investigation and a synopsis of the results achieved, should be addressed to: Mr. T. F. Burton, Society of Chemical Industry, Clifton House, Euston Road, London, N.W.1.

A Sensitive Induction Magnetograph

A SENSITIVE induction magnetograph for measuring the time-rate dH/dt of the horizontal component of the earth's magnetic field is described by H. Nagaoka and T. Ikebe in *Scientific Papers of the Institute of Physical and Chemical Research* (Tokyo) of August 1939. The magnetograph embodies a design of a special shape for collecting the lines of force into a permalloy core enclosed in a cylindrical coil. A record is given of complicated magnetic disturbances caused by electric trams. Even at a distance of several hundred kilometres from a great city, the disturbances can be detected as minute ripples on the traces. The selection of an observing station for observing true geophysical phenomena is therefore a difficult problem. The observed effect of weak earthquake shocks is discussed. Apart from the purely mechanical effects of shock, there are probably

some true magnetic effects due to the varying magnetic susceptibility of erupting lava (the subject of study being the Asawa volcano). The authors think that it may be possible to predict violent eruptions half an hour before they occur. It is also anticipated that the new magnetograph will provide data to test whether short-period disturbances of a few seconds' duration exist during magnetic storms. Provided that a suitable site can be obtained, the magnetograph has other applications in the study of the characteristics of the *E*- and *F*-layers of the ionosphere with respect to the height of origin of the current system producing the diurnal variation of the earth's magnetic field.

Apia Observatory

The annual report for 1935 of the Apia Observatory, issued by the New Zealand Department of Scientific and Industrial Research, bears witness to useful systematic work in several sections of geophysical research carried out at the Apia Observatory. The observations are grouped under terrestrial magnetism, seismology, meteorology, and atmospheric electricity. The meteorological observations include pilot balloon ascents for upper air data and the preparation of daily synoptic charts of the weather in the region of the South Pacific islands. A time service is also maintained. A glance at the meteorological records shows that conditions from the observer's point of view must often be difficult. The mean monthly temperature at 9h. usually exceeds 80° F.; there is much rain in some months, and relative humidity is invariably high. On January 16, 1935, a fall of more than 13 inches of rain was recorded, the total for the month being about 41 inches. Apia Observatory was established in 1902 in connexion with the German South Polar Expedition. The magnetic section of the Observatory was constructed in 1912, the seismograph installed in 1913, while the atmospheric electricity apparatus was housed in 1922–1924 through grants from the Department of Terrestrial Magnetism, Carnegie Institution of Washington. In 1921, the Observatory was formally taken over by the New Zealand Government, which has borne throughout the greater part of the cost of maintenance, although substantial annual grants have been made by the Carnegie Institution of Washington and by the British Admiralty.

The World's Largest Generating Station

Few engineers in Great Britain know much of the progress that is being made in the hydro-electric plant which is being erected at the Samara bend on the Volga by Soviet engineers. The *Electrical Times* of October 26 suggests that a study of the map of Russia will show that the lie of the land at this bend is ideal for the building of a huge hydro-electric plant. Imagine a hairpin bend of the river with the town of Samara containing about 60,000 inhabitants at the top of the bend. The two legs of the hairpin extend west and embrace a ridge of mountains. About thirty miles west of the town is a ravine in these hills, where a small tributary cuts through northward to join the Upper Volga at Stavropol. This would make an ideal site for a power-house as the pipe lines would short-circuit something like 75 miles of a falling river. The plant when completed is to have a generating capacity of 3·4 million kilowatts. We know that the six stations at Niagara have a total water power of 1·6 million horse-power. Boulder Dam will have an ultimate water-power of 1·3 kilowatts but its main purpose is for irrigation, and as electric power is only a side product it would therefore generate much less electricity than the Volga power station, which may therefore claim to be the world's largest power project. This is a case in which electricity seems to be shaping the geography of a country. Much of the Samara power will be transmitted and probably, considering the immense distances to which it will be transmitted, a voltage of 300,000 or more will be used. Local industries will almost certainly group themselves round the power station, as they have done in several places under Soviet control, and a large new town will grow up.

Farm Forestry in the United States

A most interesting little booklet entitled "Farm Forestry" by W. A. Ross and W. R. Mattoon has recently been issued by the Office of Education, Department of the Interior, United States (Vocational Division Bulletin No. 196, Agricultural Series No. 52, U.S. Govt. Printing Office, Washington, 1939). The material in the bulletin has been prepared to provide teachers of what is termed vocational agriculture with valuable subject-matter written in a practical fashion to enable them to offer more effective systematic instruction on certain forestry work on the farm. The United States, it is said, contains some 470,000,000 acres of land which is classified as forest land. In addition there are several million acres which economists say are in excess of what will be required for the production of field crops and the raising of live-stock and which are therefore available for forestry purposes. Timber is now a recognized crop in diversified farming programmes. Much of the booklet may be read with interest in its application to Great Britain. The United States has, as is well known, some difficult problems to solve owing to excessive lumbering of forest and excessive crop-growing on soils not applicable to such treatment. The so-called dust bowls have shown the direction to which such over-utilization leads. The hints given in this bulletin are therefore of major importance to the farmer.

Land-grant Colleges in the United States

An English farmer remarked that, when he arrived in Honolulu in 1907, he was surprised to find two experts on the spot, ready to advise on forestry and agriculture, supply seeds and lend money on small holdings. This is one result of the far-flung enterprise of the United States which appears in "The Land-grant Colleges", a paper-covered monograph prepared for the Advisory Committee on Education appointed by the President in 1936 (Washington, D.C.: G.P.O. 25 cents). The authors trace the rise and broadening

of the movement from its beginnings in 1862. They do not give instances of the actual working of the scheme in any particular case, but its development as a whole is clearly indicated with tables of statistics and comments. As the Acts which control the working of the colleges are no fewer than nine, a certain amount of friction with the State authorities is inevitable. States differ in their resources and needs. But the authors agree that some Federal control of the research to be made is wise. An Act of 1935 arranged that Federal funds need not be "matched" by the State contributions—a sensible provision. Agriculture is the main subject. Home economics appear to languish, from a table of time spent from 1928 until 1936. Experimental stations, as in agriculture, can scarcely be arranged. But Morrill's initiative in 1862 has certainly proved fruitful for the farmer, if it has not provided the liberal education he contemplated. One difficulty to be faced is the duplication of work already being done by schools and colleges.

Assistant for India at Kew

Mr. C. E. C. Fischer, assistant for India at the Royal Botanic Gardens, Kew, is to retire shortly. He joined the Herbarium in January 1925, while on furlough preparatory to retirement from the Indian Forest Service, which had been spent mainly in the Madras Presidency. In the same year the death of Mr. J. S. Gamble left the "Flora of the Presidency of Madras" unfinished, and Fischer was charged with the completion of the work. This involved the working out of the seven families of Dicotyledons, the Coniferæ and the whole of the Monocotyledons. As assistant for India in the Herbarium he was also responsible for the identification of material from all parts of the Indian Empire, which during recent years has been mainly from Burma, the Himalayas including Southern Tibet, and the Madras Presidency. On Mr. Fischer's retirement in December, he will be succeeded by Mr. K. N. Kaul, who has already spent nearly six months at Kew. Mr. Kaul is a graduate of the University of Lucknow, where he has worked under Prof. B. Sahni.

Announcements

Prof. J. Gray, professor of zoology in the University of Cambridge, will deliver the Croonian Lecture of the Royal Society on November 16 at 2.30 p.m. The title of Prof. Gray's lecture is "Aspects of Animal Locomotion".

Dr. William W. Graves, professor and director of the Department of Neuro-psychiatry, St. Louis School of Medicine, has received the Award of Merit of St. Louis Medical Society for his studies on inherited variations in relation to the problems of the human constitution.

An institute for industrial medicine and particularly for the prevention and control of diseases due to dust will be opened shortly at Iglesias in Sardinia.

The community education section of the American Dietetic Association has recently published a bibliography of normal nutrition. It can be obtained at the office of the Association, 185 North Wabash Avenue, Chicago, at 10 cents a copy.

The work of the Eugenics Society will be carried on at 69 Eccleston Square, London, S.W.1, during the war, and an emergency committee has been appointed, with full powers to act on behalf of the council. The quarterly publication of the *Eugenics Review* will be continued under the editorship of Dr. Maurice Newfield.

According to a circular recently issued by the International Academy of the History of Sciences, the fifth International Congress of the History of Sciences will be held at Lausanne in September 1940, if the political and social situation of Europe permits. The permanent secretary of the Academy, M. Aldo Mielli, having now settled at Santa Fé in the Argentine Republic as director of the history of science in the University of Santa Fé, M. J. A. Vollgraff of Leyden has been appointed assistant secretary for Europe and the Mediterranean countries. The review *Archeion*, the official organ of the Academy, will henceforth be published at Santa Fé instead of at Rome as hitherto.

The Finney-Howell Research Foundation, Inc., announces fellowships for 1940. This Foundation was provided for in the will of the late Dr. George Walker of Baltimore for the support of "research work into the cause of causes and the treatment of cancer". Fellowships carrying an annual stipend of 2,000 dollars are awarded for the period of one year, with the possibility of renewal up to three years; when deemed wise by the Board of Directors, special grants of limited sums may be made to support the work carried on under a fellowship. Applications for fellowships for 1940 should be made at the office of Foundation, 1211 Cathedral Street, Baltimore, Maryland, by January 1, 1940.

Reference was made in Nature of October 21, p. 714, to the British Association Research Committee on Blood Groups among Primitive Peoples; it should have been stated that the work referred to was done by, and under, Prof. R. Ruggles Gates.

Under the title "Prehistoric Indian Village, New Mexico" reference was made in Nature of September 23, p. 542, to the work of an expedition under the leadership of Dr. Paul S. Martin. We are informed that Dr. Martin is, and has been for several years, chief curator of the Department of Anthropology of the Field Museum of Natural History, Chicago, and the expedition referred to is the ninth that Dr. Martin has undertaken for the Museum. The statement that the expedition was sent out by the American Museum of Natural History of New York is incorrect.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. They cannot undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.*

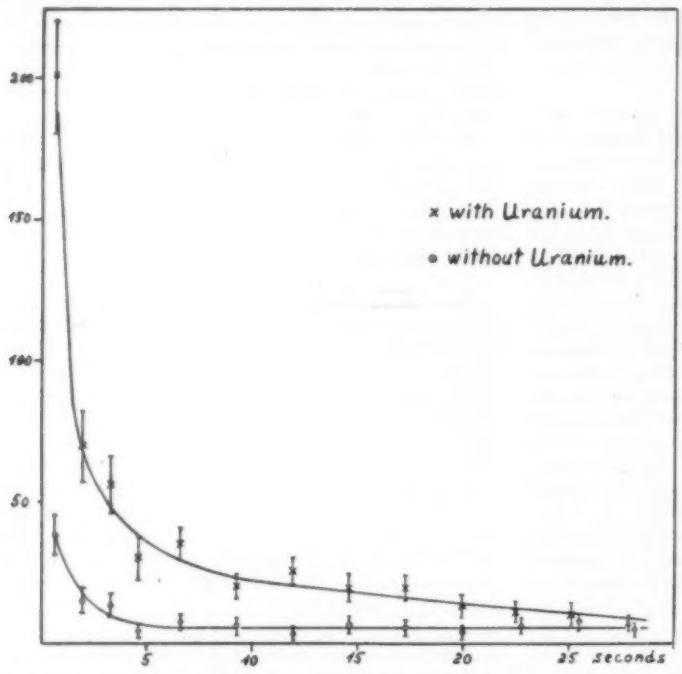
NOTES ON POINTS IN SOME OF THIS WEEK'S LETTERS APPEAR ON P. 836.

CORRESPONDENTS ARE INVITED TO ATTACH SIMILAR SUMMARIES TO THEIR COMMUNICATIONS.

Delayed Neutron Emission accompanying Uranium Fission

As first observed by Roberts, Meyer and Wang[1], the fission of uranium is followed by an emission of neutrons with a delay of about 12 seconds. As this period corresponds roughly to a β-ray period of about 10 seconds previously found by Meitner, Hahn and Strassmann[2] in their study of the uranium neutron reactions, it was suggested that the neutron emission is directly connected with the process of β-ray emission. Further experiments[3] confirmed this conclusion and led to an estimate for the cross-section for the production of such delayed neutrons of about 4×10^{-26} cm.^{2}. The subsequent work of Booth, Dunning and Slack[4] established the existence of an additional period of about 45 seconds, which could also be brought into connexion with a known β-ray period of the uranium products.

The theoretical analysis of the problem by Bohr and Wheeler[5] points to a simple explanation of these results, and suggests also the possibility of still shorter periods both for β-ray and neutron emission. The existence of two additional β-ray periods of 0·3–0·9 and 3–4 seconds was, in fact, established by the recent experiments of Barschall, Harris, Kanner and Turner[6]. Experiments were then initiated in this laboratory to ascertain whether the corresponding neutron periods occur.



In these experiments, 1½ kgm. of uranium nitrate surrounded by paraffin were exposed to the neutrons from a lithium target bombarded by a deuteron beam of 900 kv. and 20 microamperes. The beam was intermittently cut off by means of a switch in the power supply to the ion source. The neutrons emitted from the uranium were detected in a boron-lined ionization chamber placed immediately under the uranium container. The pulses from the ionization chamber were amplified and recorded on an oscillograph operated synchronously with the ion source.

The accompanying figure gives the result of measurements made after irradiation periods of 18 seconds and interspersed with control measurements without uranium. The 12-second period previously reported is clearly shown. In addition, a decay of the neutron emission of shorter period is apparent with a starting intensity somewhat larger than that given for the 12-second period. Besides showing the presence of a period of about 3 seconds, the figure gives also some indication of a period between 0·1 sec. and 0·3 sec. However, the definite establishment of such a short period is rendered difficult by the large background shown in the curve taken without uranium. This background is due to electrical disturbances from the high-tension equipment occurring when the ion source is turned off, and it is hoped that by more careful shielding of the amplifier the effect may be reduced in continued experiments.

Recently, Gibbs and Thomson[7] have reported similar investigations with an intermittent ion source of special construction allowing the study of periods as short as 10^{-3} sec. Because of the low neutron intensities available to them, they could not detect any definite neutron period in the range from 10^{-2} to 10 seconds, and were only able to conclude that the total cross-section for the production of such periods was at any rate not much larger than 10^{-25} cm.^{2}.

Assuming that the cross-section for the 12-second period[3] is 4×10^{-26} cm.^{2}, the total cross-section given by our experiments for periods down to about 0·1 sec. is less than 2×10^{-25} cm.^{2}. The experiments of Gibbs and Thomson are, therefore, in no way in disagreement with ours, and indicate further that there are no intense periods between 10^{-3} sec. and 10^{-1} sec., in accordance with theoretical expectations[5], considering the lack of very hard β-rays accompanying the fission process[6].

We are obliged to Prof. Niels Bohr for suggesting the problem, and to Prof. T. Bjerge and Dr. O. R. Frisch for valuable advice in the setting up of the experiments.

K. J. Bostrøm.
Institute of Theoretical Physics, J. Koch.
University of Copenhagen. T. Lauritsen.
Oct. 7.

[1] Roberts, R. B., Meyer, R. C., and Wang, P., *Phys. Rev.*, **55**, 510 (1939).
[2] Meitner, L., Hahn, O., and Strassmann, F., *Z. Phys.*, **106**, 249 (1937).
[3] Roberts, R. B., Hafstad, L. R., Meyer, R. C., and Wang, P., *Phys. Rev.*, **55**, 664 (1939).
[4] Booth, E. T., Dunning, J. R., and Slack, F. G., *Phys. Rev.*, **55**, 876 (1939).
[5] Bohr, N., and Wheeler, J. H., *Phys. Rev.*, **56**, 426 (1939).
[6] Barschall, H. H., Harris, W. T., Kanner, M. H., and Turner, L. A., *Phys. Rev.*, **55**, 989 (1939).
[7] Gibbs, D. F., and Thomson, G. P., Nature, **144**, 202 (1939).

Resonance Capture of Slow Neutrons and Emission of Gamma-Rays

The determination of neutron resonance energies of nuclei which are made radioactive after neutron capture is possible by utilizing their activities, and several such cases are known; for example, silver, rhodium, iodine, indium, gold, etc. But in the cases of nuclei which are not made radioactive, it is much more difficult to discover the existence of resonance neutron groups and to determine their energies. H. A. Bethe[1] has suggested several methods for such cases, but no noteworthy results have been obtained except that of A. E. Dowing and C. D. Ellis[2].

S. Nishikawa and others[3] have pointed out that it is possible to detect the resonance groups by an analysis of the activity curve as a function of thickness of paraffin layer interposed between a radon plus beryllium source and a detector which became radioactive by neutron capture. A similar experiment was carried out by Y. Sugiura and O. Minagawa[4] with a D + D neutron source.

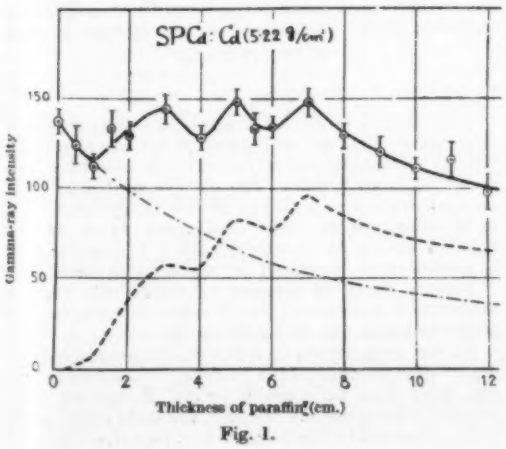


Fig. 1.

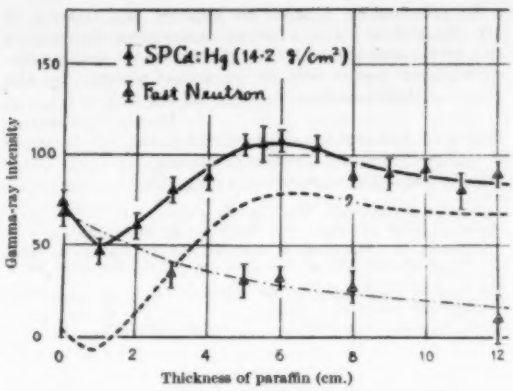


Fig. 2.

In the case of non-active substances, however, it may be possible to utilize the gamma-rays emitted in the capture process itself. Following this idea, the gamma-ray intensity was measured for iron, cadmium, mercury and bismuth by a Geiger-Müller counter as a function of the thickness of paraffin layer interposed between a D + D neutron source and a detector. When thermal neutrons were interrupted by a cadmium filter interposed in an appropriate position, the gamma-ray intensity curve should have one maximum at a certain thickness of paraffin if the detector had one resonance level. The position of the maximum would depend on the energy of the resonance level.

Gamma-ray intensity curves obtained for cadmium and mercury are shown in Figs. 1 and 2. As gamma-rays are excited also by fast neutrons, it is necessary to subtract this part of the gamma-rays in order to get the effect of slow neutrons only. The number of fast neutrons which can excite gamma-rays is calculated as a function of paraffin thickness on the assumption that a fast neutron can excite gamma-rays only when its energy is greater than 1·9 Mev., an average of the values of maximum quantum energies of fast neutron gamma-rays obtained by H. Aoki[5]. The result of the calculations is shown in Fig. 1 or 2 (broken line). An experiment was performed to test this calculated result by absorbing slow neutrons by a thick layer of boric oxide (0·78 gm./cm.^{2} of boron). The result is shown in Fig. 2, after being corrected for the residual effect of slow neutrons.

From analyses of gamma-ray intensity curves and measurements of energy by the boron absorption method, it can be shown that mercury has a clear resonance group of about 10 ev. in energy, cadmium has several groups of energies from several tens to a few electron volts, and the mean energy of these groups, plus the residual part of the first resonance group ($E_r = 0{\cdot}17$ ev.) not absorbed by the cadmium filter, is about 2 ev. Bismuth has a resonance group giving a flat maximum of gamma-ray intensity at about 5–7 cm. thickness of paraffin. Iron has no distinct groups.

For thermal neutrons the maximum of gamma-ray intensity was found at 9 cm.

In conclusion, I wish to express my thanks to Mr. Masamichi Tanaka for encouragement throughout this work, and also to Mr. O. Minagawa for discussions. A detailed report will be published shortly by the Physico-Mathematical Society of Japan.

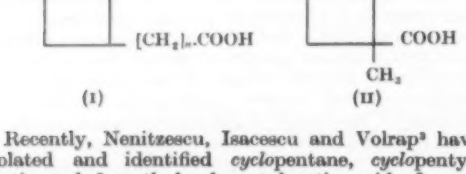
Itaru Nonaka.

Research Laboratory, Matsuda Division,
Tokyo-Shibaura Electric Company,
Kawasaki, Kanagawaken. Aug. 29.

[1] Bethe, H. A., *Rev. Mod. Phys.*, **9**, 139 (1937).
[2] Dowing, A. E., and Ellis, C. D., Nature, **142**, 793 (1938).
[3] Nishikawa, S., Nakagawa, S., and Sumoto, I., *Proc. Imp. Acad. Tokyo*, **12**, 128 (1936); *Sci. Pap. Inst. Phys. Chem. Res.*, **34**, 1, (1937).
[4] Sugiura, Y., and Minagawa, O., *Sci. Pap. Inst. Phys. Chem. Res.*, **34**, 1299 (1938).
[5] Aoki, H., *Proc. Phys. Math. Soc. Japan*, **19**, 369 (1937).

A Solid Naphthenic Acid from Iranian Petroleum

The importance of the study of the naturally occurring acidic constituents of petroleum, both in the recognition of the individual hydrocarbons from which they are derived and in their application in the domains of medicine and technology, has been stressed by v. Braun[1]. Although, however, the naphthenic acids have been recognized for more than sixty years, owing to the fact that many isomers are possible, it is only comparatively recently that pure individuals have been isolated, many, which had previously been reported as pure, having been proved to be mixtures. v. Braun, Mannes and Reuter[2] are usually considered to have been the first to isolate a homogeneous naphthenic acid by a rather indirect route. Degradation of mixtures of acids of the general formula $C_{10}H_{18}O_2$ from different sources gave the same 3.3.4-trimethyl*cyclo*pentanone, which was reconverted to 3.3.4-trimethyl*cyclo*pentylacetic acid. All the higher acids $C_n H_{2n-2} O_2$, out of which the above ketone could be obtained by degrading one or more times, therefore correspond to the formula (I) (v. Braun *et alia*, *loc. cit.*)



(I) (II)

Recently, Nenitzescu, Isacescu and Volrap[3] have isolated and identified *cyclo*pentane, *cyclo*pentylacetic and 3-methyl*cyclo*pentylacetic acids from a Rumanian source.

During an investigation of the caustic washing liquors after use in removing traces of acid from a kerosene sulphur dioxide extract derived from Iranian petroleum, the presence of naphthenic acids in an oil from this source was proved for the first time. A subsequent investigation showed that naphthenic acids occurred in the kerosene sulphur dioxide extract to the extent of approximately 0·025 per cent by weight, of which about 10 per cent was removed by the light caustic washing. The spent caustic washing liquors after washing 2,000 gallons of kerosene sulphur dioxide extract were neutralized and the precipitated oil worked up in the usual manner into acidic, phenolic, mercaptan and hydrocarbon fractions. The acidic material was esterified three times by means of methyl alcohol and hydrochloric acid, whereby all the primary and secondary acids could be removed from the difficultly esterifiable tertiary acids.

The residual tertiary acids on standing for a few days yielded a white crystalline solid which after many crystallizations from low boiling petrol had constant m.p. 82° (found, C, 70·90; H, 10·74; $C_{10}H_{18}O_2$ requires C, 70·52; H, 10·66 per cent; molecular weight by titration: 173; $C_{10}H_{18}O_2$ requires 170). The anilide crystallized in colourless flat needles from aqueous methyl alcohol, m.p. 186–7° (found C, 78·32; H, 9·38; N, 5·73; $C_{16}H_{23}ON$ requires C, 78·30; H, 9·45; N, 5·71 per cent). By fractional crystallization of the mother liquors a total yield of 3·3 per cent of the acid was obtained on the original acid mixture from the caustic washing liquors. The acid proved to be saturated, and must therefore contain a closed carbon ring.

In line with the results of Nenitzescu *et alia* (*loc. cit.*) and of v. Braun *et alia* (*loc. cit.*), it is suggested that the above acid possesses a polymethyl*cyclo*pentyl structure, possibly (II). Further information will be published elsewhere when larger amounts are available for study.

I wish to record my thanks to the chairman of the Anglo-Iranian Oil Company, Limited, for permission to publish these results.

Since this work was completed, a publication by Hancock and Lochte has appeared[4] describing the isolation of a solid tertiary naphthenic acid, m.p. 194–194·5°, from a California straight-run gasoline distillate which they have shown to be identical with camphonanic acid (1.2.2-trimethyl-*cyclo*pentanecarboxylic acid).

Thomas Kennedy.

Anglo-Iranian Oil Co., Ltd.,
Research Station,
Sunbury-on-Thames. Oct. 4.

[1] "Science of Petroleum", **2**, 1014 (Oxford).
[2] *Ber.*, **66B**, 1499 (1933).
[3] *Ber.*, **71B**, 2056 (1938).
[4] *J. Amer. Chem. Soc.*, **61**, 2448 (1939).

Carbamates of α-Amino-Acid Esters and their Polycondensation

On passing a stream of carbon dioxide through strongly cooled, pure α-amino acid esters or their solutions (for example, in ether) with certain precautions, new crystalline products have been obtained. After careful purification the products give analytical data which correspond to the formulæ of carbamates of the α-amino acid esters of the general formula

$$\begin{array}{l} RCH.NH.COOH \\ \quad\quad | \\ \quad COOR_1 \end{array}$$

A number of them, for example, glycine carbamate ethyl ester, alanine carbamate ethyl ester, phenylglycine carbamate ethyl ester, have now been prepared and analysed. The new compounds show various degrees of stability at low temperature. At room temperature they decompose more or less rapidly, giving off carbon dioxide; the dissociation is considerably increased on warming *in vacuo*.

Besides being of interest in itself, this class of amino-acid derivatives is of value in carrying out poly-condensations of amino-acids.

As has been shown in a previous communication[1], amino-acid esters exhibit a tendency to condense, forming, *inter alia*, polypeptide esters of varying chain length. This tendency of the amino-acid esters seems to be enhanced by the introduction into their molecule

of the readily cleavable COO-group, removal of which is bound to leave an NH_2-group *in statu nascendi* behind.

According to Curtius and to E. Fischer, the glycine ethyl ester on standing for several weeks gives as highest condensation product the biuret base, the tetraglycine ethyl ester. Under similar conditions, glycine ethyl ester carbamate yields a mixture which according to the analytical data seems to contain, *inter alia*, glycine peptide esters of considerably higher chain length.

From alanine carbamate ethyl ester a product was obtained which gave the biuret reaction. From this mixture, tetra-alanine ethyl ester was isolated.

Systematic experiments on the synthesis and properties of carbamates of the various representative amino-acid and peptide esters and on their condensation are in progress.

Max Frankel.
Otto Neufeld.
Ephraim Katchalski.

The Hebrew University,
Jerusalem.
Sept. 15.

[1] Frankel, M., and Katchalski, E., Nature, **144**, 330 (1939).

An Easily Arranged Periodic Action

Lecturers wishing to demonstrate the existence of periodic phenomena may be interested in a description of a periodic action that can be set up in a few minutes.

The surface of a sheet of lead was amalgamated with mercury and while it still possessed some fluidity a drop of concentrated nitric acid was placed on it. Spreading started immediately, but ceased when the diameter of the area of wetting reached about 1·5 cm. After an induction period of about a minute, during which time there was no apparent action, a considerable evolution of gas occurred at the mercury surface, but this continued only for a fraction of a second. Periods of apparent quiescence and gaseous evolution then followed regularly, at intervals of about a second. Pulsations continued for some minutes, until lead nitrate crystallized from the liquid phase.

The presence of mercurous nitrate in the nitric acid facilitated the initial amalgamation, but the surface had to be dried before the acid was placed upon it, otherwise spreading proceeded too far. Some factor not yet identified caused variations in the period of the cycle. With some specimens of lead of doubtful purity it was necessary to dilute the acid with up to one third of its own volume of water in order to get pulsations of sufficiently long period to be readily observed.

The reaction seems to be that lead (not mercury) dissolves, with liberation of nitrogen peroxide or other oxides of nitrogen.

E. E. Wark.
I. W. Wark.

University of Melbourne,
Carlton, Melbourne, N.3.
Aug. 26.

Effect of Irradiating the Tubercle Bacillus with Radon

Immunity against the tubercle bacillus seems to be due to the presence of living bacteria in the body; it is then of importance to obtain non-virulent but living bacteria. The virulence of pathogenic bacteria is generally attributed to their power of multiplication. In actual fact, this is the result of two independent variables:

(1) The toxicity factor T or the mean toxicity potential of the bacteria. This potential for a stable strain is first of all dependent on the host and secondly on the mode of innoculation (excipient, medium, rhythm). Specificity might be connected to this factor.

(2) The numerical factor N_t, or the number of bacteria *in vivo* at a given moment of the infection. Schematically, $V = T.N_t$, N_t being itself a function of N_0, the number of bacteria injected and of their time of generation *in vivo*.

The virulence of a bacterium may then be influenced by acting on either of these factors or on both of them. Calmette acted on the toxicity factor, obtaining B.C.G.; we preferred to act on the numerical factor, inhibiting proliferation without modifying, so far as possible, the other cellular functions. Among the physico-chemical agents available, we selected the ionizing radiations, as most suitable for our purpose.

We have irradiated aqueous suspensions of human tubercle bacillus (1 mgm./c.c.) using the whole of the radiation of radon dissolved in the culture. The technique we have elaborated enables us to obtain reproducible results depending exclusively on the doses employed, given in microcurie destroyed per cubic centimetre of the bacterial emulsion. (One microcurie disintegrated (1 μc.) corresponds to the emission of $5{\cdot}5 \times 10^{10}$ α-particles, $3{\cdot}6 \times 10^{10}$ β-particles and to the formation of 10^{10} pairs of ions or 5×10^3 r. An area of $0{\cdot}5\ \mu^2$ (mean cross-section of a B.K.) is traversed at this dosage by 1·2 α-particle and 33 β-particles. The γ-radiations are negligible.) The following results are observed.

(1) More than 9 μc. radon disintegrated. Proliferation on Löwenstein medium is regularly suppressed. The form of the curve showing the relation between the number of surviving bacteria and the dose employed could not be traced with precision owing to the uncertainty of counts on this medium. If, as it seems, this curve is of exponential form, the effect of 1·5 μc. corresponds to a dilution of 1/10 of the surviving bacteria.

(2) Cultures thus irradiated remain virulent for the guinea pig up to 14 μc. Above 15 μc., guinea pigs which received under the skin of the thigh 5 mgm. of irradiated B.K. remain unaffected.

(3) *Persistence of respiration of irradiated non-virulent B.K.* It was of importance to assure oneself that the bacteria the virulence and proliferation of which were destroyed, still possess vital properties. This has been done in the following way.

An emulsion of living B.K. was divided into three parts: one was irradiated at 20 μc., the second left untouched and the third killed at 120° C. These suspensions, to each of which 5 per cent of buffered glycerine (*p*H 6·8) was added, were placed in the vessels of a Warburg respirometer. The experiment was conducted under sterile conditions, each vessel being separated from its manometer by a piece of sterilized cotton (Rapkine). It has been established that the irradiated bacteria still respire for about five days. The consumption of oxygen during this period is about 20 per cent that of an equal weight of living bacteria. Thus there remains at least 20 per cent of living bacteria in the irradiated suspension.

While we cannot report fully here on the anti-tuberculosis immunity obtained with irradiated bacteria, we may nevertheless enumerate the following facts.

(1) Guinea pigs vaccinated with such bacteria and tested with 1/50 mgm. of virulent B.K. show a survival (250 ± 40 days) double that of controls (133 ± 30 days), the difference being statistically significant.

(2) A regular decrease of temperature and an improvement of the lesions have been observed in most of the cases of tuberculosis, bony, ganglionar, kidney and pulmonary, under treatment (60 cases). The complete harmlessness of the vaccine has been established even in very serious cases; the radio-vaccine never caused recrudescence.

Thus the action of ionizing radiations enables us to obtain living human tubercle bacillus which are non-virulent; this would seem to be of particular interest to immunologists.

Laboratoire Curie,
Institut du Radium,
11 Rue Pierre-Curie,
Paris, 5e.
Sept. 15.

P. Bonet-Maury.
H. R. Olivier.

Necessity of Magnesium in the Pyruvate Oxidation System of Brain*

The necessity of Mg++ in enzymic reactions involving transfer of phosphate groups through the adenylic acid system is well known. More recently, Mn++ has also been shown to be active in reactions of this type[1]. Further, Auhagen[2] and later Lohmann and Schuster[3] showed that the decarboxylation of pyruvic acid by yeast requires Mg++ (or Mn++). This made it likely that these ions are also necessary for the oxidative breakdown of pyruvic acid in animal tissues, the more so as this breakdown is related with reactions involving the adenylic acid system[4].

Stimulation by Mg++ of the oxidative decarboxylation of pyruvate by washed muscle preparations was reported by Annau and Erdös[5]. Addition of Mg++ has little or no effect on the oxidation of pyruvate by dispersions from pigeon brain[4] after short dialysis periods (2–3 hours), but the effect is more marked if the dialysis is extended for periods of 8 hours. A clearer demonstration has, however, been obtained by adding to the enzyme an excess of sodium pyrophosphate (0·0067 *M.*) to precipitate magnesium. Pyrophosphate is then removed to the extent of 90 per cent by 8 hours dialysis, when its concentration is of the order of 0·0007 *M.* and is, by itself, without effect on the respiration of the brain preparations. The preparations which have, however, been treated as described above give with pyruvate nearly one third of the oxygen uptake which can be obtained by adding Mg++. These facts are illustrated in the table below. Samples contained 1·5 ml. enzyme (dialysed 8 hours), brought to a volume of 2 ml. with additions including phosphate buffer *p*H 7·3 (0·05 *M.*), fumarate (0·005 *M.*), adenylic acid (0·0007 *M.*), and cozymase (0·00007 *M.*).

Treatment	Pyruvate	Mg++ (as $MgCl_2$)	Mn++ (as $MnCl_2$)	μl. oxygen uptake in 30 min. (air, 38°)
No pyrophosphate	—	—	—	2
	—	100 γ	—	61
	2 mgm.	—	—	280
	2 ,,	100 γ	—	432
Pyrophosphate treated	2 ,,	—	—	175
	2 ,,	100 γ	—	400
	2 ,,	150 γ	—	455
	2 ,,	—	100 γ	345

* These results are presented here owing to the temporary discontinuance of the meetings of the Biochemical Society.

Mg++ (or Mn++) is therefore a component of the pyruvate oxidation system.

I am indebted to the Nuffield trustees for grants in aid of this work.

Department of Biochemistry,
Oxford. Sept. 30.

S. Ochoa.

[1] Ohlmeyer and Ochoa, *Biochem. Z.*, **293**, 338 (1937).
[2] *Z. physiol. Chem.*, **269**, 20 (1932).
[3] *Biochem. Z.*, **294**, 188 (1937).
[4] Banga, Ochoa and Peters, NATURE, **144**, 74 (1939).
[5] *Z. physiol. Chem.*, **257**, 111 (1939).

Sex Difference in the Response of the Pigeon Crop-Gland to Prolactin

It has generally been thought[1] that there is no detectable sex difference in the response of the pigeon crop-gland to prolactin. Folley and White[2], however, were able to demonstrate a significantly greater response in males than in females, a finding which has since been confirmed by Bates and Riddle[3] for subcutaneous but not for intramuscular injections.

Preliminary examination of more extensive results which have accumulated in this laboratory in the course of further experiments on the inhibition by œstrogens of the prolactin response[4] appeared at first sight to indicate no sex difference in response. Since, however, re-examination of the original records of Folley and White revealed that their groups consisted almost entirely of immature birds, a further analysis of the above-mentioned data, in which the birds were classified as mature and immature on the basis of gonad size at autopsy, was undertaken. Details of the experimental technique are given elsewhere[4], the birds referred to below comprising the prolactin and oil-injected controls together with a group of birds used for constructing a dose-response curve.

The following results relate to two groups of birds receiving the same daily dose of prolactin but different doses of sesame oil (these were also combined to make a third group on the reasonable assumption that the sesame oil injections had no effect on the prolactin response) and a fourth group receiving a lower dose of prolactin. For groups of 'mature' birds the mean male crop weights exceeded those of females by 0·11, 0·06, 0·08 and 0·17 gm. per 100 gm. body weight respectively, the corresponding values of P (Fisher's 't' test[5]) being 0·3–0·4, 0·5–0·6, 0·3 and 0·2–0·3. For 'immature' birds the mean crop weights of males were 0·30, 0·31, 0·36 and 0·11 gm. per 100 gm. body weight greater than those of females. Here the values of P were 0·14, 0·076, 0·01–0·02 and 0·1–0·2.

It will be seen that for 'mature' birds the differences between the male and female crop weights were small and apparently not significant. On the other hand, in 'immature' birds receiving the higher dose of prolactin the differences were much larger and the significance levels much higher. It therefore appears that this sex difference in response to prolactin is most marked in pigeons with undeveloped gonads.

S. J. Folley.
National Institute for Research in Dairying,
Shinfield, Reading.
Oct. 1.

[1] Rowlands, I. W., *Quart. J. Pharm. and Pharmacol.*, **10**, 216 (1937).
[2] Folley, S. J., and White, P., NATURE, **140**, 505 (1937).
[3] Bates, R. W., and Riddle, O., *J. Biol. Chem.*, **123**; *Proc. Amer. Soc. Biol. Chemists*, 5 (1939).
[4] Folley, S. J., *Endocrinology*, **24**, 814 (1939).
[5] Fisher, R. A., "Statistical Methods for Research Workers" (Edinburgh: Oliver and Boyd, 1934).

Histological Effects of Diabetogenic Anterior Pituitary Extracts

At the request of Prof. C. H. Best, in whose department studies were being made on other aspects of the diabetogenic effects of pituitary extracts, we made a histological study of the tissues of dogs which were receiving daily injections of an anterior lobe extract. The clinical evidences of diabetes as well as the results of insulin assays on the pancreases of these animals is reported elsewhere (Best, Campbell and Haist[1]). For our work, pancreas tissue was obtained under anæsthesia, other tissues shortly after death. Tissues were fixed in Zenker-formol and Bouin's solution and sectioned in paraffin. Three micron pancreas sections were stained by the Mallory-azan technique, Bowie's stain and other methods giving islet cell differentiation. Hæmatoxylin and eosin sections were prepared from all the organs. The histological findings are summarized in the following table.

Number of days injected	2	3 and 4	7	11*
Beta cell granules	Slight deplet.	Moderate deplet.	Moderate deplet.	Marked deplet.
Alpha cells	No change	No change	No change	No change
Mitoses in islets	One seen	A few	Several	None seen
Hydropic degen.	Not seen	Trace	Trace	Marked
Vacuoles in duct epithelium	Not seen	Marked	Marked	Marked
Mitoses in duct epithelium	Not seen	A few	Many	A few
Mitoses acini	Not seen	A few	Many	None seen
Type of thyroid epithelium	High colum.	High colum.	High colum.	Cuboidal
Colloid content thyroid	Slight reduct.	Mod. reduct.	Mod. reduct.	Slight reduct.
Mitoses thyroid	Many	Many	Many	None seen
Mitoses adrenal Cortex	Many	Many	Many	None seen
Mitoses parathyroid	Many	Many	Many	Not exam.
Liver degen.	Not seen	About cent. veins	Severe	Not so severe
Mitoses liver	Not seen	Not seen	Not seen	Many
Mitoses kidney	Not seen	Not seen	Many in Loop of Henle	None seen

* Two dogs were injected for eleven days. The findings of one were similar to those presented for dogs injected seven days, the findings of the other are presented in this column.

Note. (1) The first seven items are concerned with the pancreas; (2) three- and four-day dogs are grouped together to save space, but the findings in them although similar are not identical; (3) one dog injected only once is not included in the table; it showed no change except a heightening of the thyroid epithelium; (4) each dog was sacrificed twenty-four hours after its last injection.

Although islet degeneration is pronounced in permanent pituitary induced diabetes (Richardson and Young[2], Campbell and Best[3]), our findings suggest that temporary diabetes has a much more complicated histological basis. In the early stages of the condition we did not find a great deal of islet degeneration; moreover, there were profound changes in many other organs related to carbohydrate metabolism.

The remarkable amount of cell division in the thyroid, parathyroid and adrenal cortex indicates that the extract contained these glands' respective tropic principles. Cell division in the ducts, acini and islets of the pancreas likewise indicates a pancreatropic principle in the extract. Anselmino, Herold and Hoffmann[4] first postulated such an extract and Richardson and Young[5] have shown that injections of a crude saline extract of anterior lobe causes both the islet and total pancreas tissue of the rat to increase in amount. Our findings confirm the view that there is such a principle and indicate that its action is by no means limited to islets as is so often assumed, but affects acini as well. This is only to be expected as the pancreas is both an exocrine and an endocrine gland with both elements evolving from the same stem cell. Hence a pancreatropic principle could be expected to produce the effects we observed.

Allen[6], from studies on partially depancreatectomized animals, postulated that beta cells, subjected to excessive functional strain, suffered hydropic degeneration. It therefore does not seem unreasonable to attribute the extensive hydropic degeneration we observed at eleven days to overstimulation by the pancreatropic principle in the extract. Thus we think there is no justification at present for postulating any pituitary principle which is primarily degenerative with regard to islet tissue. The paradox of a diabetogenic effect being produced by an extract containing a pancreatropic principle might be explained (1) by the extract containing many tropic principles which early in the course of the injections affect carbohydrate metabolism by acting on organs other than the pancreas, for example, thyroid and adrenal cortex, and so obscure the effect of the pancreatropic principle, and (2) by the probability that beta cells do not respond to tropic stimulation with such sustained vigour as most cells, but tend to become exhausted and even permanently injured as the injections continue.

A. W. Ham.
R. E. Haist.

Departments of Anatomy and Physiology,
University of Toronto.
Sept. 22.

[1] Best, C. H., Campbell, J., and Haist, R. E. (in the press).
[2] Richardson, K. C., and Young, F. G., *Lancet*, i, 1098 (1938).
[3] Campbell, J., and Best, C. H., *Lancet*, i, 1444 (1938).
[4] Anselmino, K. J., Herold, L., and Hoffmann, F., *Klin. Wchnschr.*, **12**, 1245 (1933).
[5] Richardson, K. C., and Young, F. G., *J. Physiol.*, **91**, 352 (1937).
[6] Allen, F. M., *J. Metabolic Research*, **1**, 5 (1922).

Occurrence of Wax-like Substances in Peaty Fireclay

Associated with the usual type of fireclay in the Ecca Series of the Karroo System in the Witwatersrand area are certain chocolate-coloured, very plastic and fine-grained refractory clays. The colouring matter is organic and mainly colloidal. The clays are difficult to disperse, unless the organic matter is totally destroyed. Owing to the fine state of division of the organic phases, mechanical separation from the inorganic material is impossible. Extraction tests in a Soxhlet apparatus with solvents specified gave the results in the table below.

In general, the extracted substances are waxy, oxidizing rapidly on heating to 110° C. to a dark brown translucent material. The green colouring matter in the alcohol extraction is not due to the presence of vanadium, a fairly commonly occurring element in clays.

Solvent	Extraction time (hr.)	Percentage extracted material	Character of extracted material
Acetone	14	0·12–0·20	Brownish translucent wax
Acetone	4	0·03–0·06	Brownish translucent wax
Ethyl alcohol	28	0·12	Light green transparent wax
Pyridene	14	0·72	Dark brown waxy material with tarry substances

Reilly and others[1] record their results on the extraction of waxy materials from peats, using an azeotropic petroleum mixture. Their yields were much greater, and the peats certainly contain much more organic matter than the fireclays.

It is noteworthy that the fireclays after extraction show no colour change, and all attempts to extract the pigmenting material have failed. Micro-incineration tests show that the organic matter burns off readily at 500–600° C. and leaves a dirty white residue. It chars far below this range. Owing to the rapid oxidation and small amounts of material, accurate melting point and other physical determinations were impossible, but the substance melts at about 90–100° C.

V. L. Bosazza.

University of the Witwatersrand,
Johannesburg.
Sept. 20.

[1] Reilly, J., Kelly, D. F., and Duff, J., *Sci. Proc. Roy. Dublin Soc.*, **22**, 149–155 (1939).

A New Record of *Phoronis hippocrepia* Wright

I found many colonies of *Phoronis hippocrepia* on limestone boulders uncovered at low water of the biggest spring tides in July and August 1939. This was on the collecting ground known in our laboratory as Black Rocks, at the eastern end of the Menai Straits. Most of the individuals had embryos attached to the lophophore.

This species must be widely distributed around the west coast of Great Britain and the English Channel, for it has been recorded from the Clyde[1], Tenby[2], Ilfracombe[3], Falmouth[4], Plymouth[4] and Sheerness[4], and also from several places on the French coast. On the other hand, anyone requiring fresh specimens might have difficulty in obtaining them. The Plymouth Fauna List does not record it as occurring on the shore although, according to Cori[5], this is the usual habitat. Mr. D. P. Wilson tells me that it is occasionally dredged at Plymouth to-day, sometimes in considerable quantities; but that it is not always easy to obtain. As for its occurrence elsewhere we have only the old records. Since the other British forms, *P. ovalis* Wright and a form resembling *P. psammophila* Cori, are probably rarer still, the presence of this species near Bangor appeared worthy of note, as it is desirable that material of so interesting an animal as Phoronis should be readily available for study.

E. W. Knight Jones.

Department of Zoology,
University College of North Wales,
Bangor.
Oct. 3.

[1] Köllicker, *Würzburg Naturw. Z.*, **5** (1864).
[2] Dyster, *Trans. Linn. Soc. Lond.*, **22** (1859).
[3] Wright, *Proc. Roy. Phys. Soc. Edin.*, **1** (1856).
[4] Garstang, *J. Mar. Biol. Assoc.*, **2** (1891).
[5] Cori, "Bronn's Klassen", **4**, Abt. 4, Buch 1, Teil 1, Leipzig (1939).

Points from Foregoing Letters

K. J. Bostrem, J. Koch and T. Lauritsen have found short periods for the delayed neutron emission accompanying uranium fission in addition to the two previously known periods of 12 seconds and 45 seconds. The results can be related with the measurements on short β-ray periods from uranium fission, and can be explained by theoretical considerations recently published by Bohr and Wheeler.

An attempt has been made by I. Nonaka to determine the neutron resonance energies of nuclei which are not made radioactive by neutron capture, utilizing the gamma-rays emitted in the capture process itself. The intensity of gamma-rays produced by slow neutrons plotted against thickness of paraffin interposed between source of neutrons and the detector shows maxima representing resonance levels in the cases of mercury, cadmium and iron.

T. Kennedy reports the isolation of a solid naphthenic acid from an Iranian petroleum fraction. The acid has the formula $C_{16}H_{18}O_2$, is saturated, contains a tertiary carboxylic acid group and one closed carbon ring. A *cyclo*pentane structure is tentatively suggested.

It has been found by M. Frankel, O. Neufeld and E. Katchalski that on passing carbon dioxide through pure α-amino-acid esters or their solutions carbamates of the α-amino esters of the general formula

$$\begin{array}{l} RCH.NH.COOH \\ | \\ COOR_1 \end{array}$$

are formed. These compounds are also valuable in carrying out poly-condensations of α-amino-acids. They form polypeptide esters of varying chain-length.

P. Bonet-Maury and H. R. Olivier describe a method which should be of value to immunologists whereby non-virulent human tubercle bacilli are produced. The non-virulent bacilli are obtained by irradiating aqueous suspensions of human tubercle bacilli, using the whole of the radiation of radon dissolved in the culture.

S. Ochoa reports that the pyruvate oxidation system of brain requires the presence of magnesium (or manganese) ions.

A. W. Ham and R. E. Haist have made a histological study of the tissues of dogs injected daily with a diabetogenic anterior pituitary extract. A complex histological basis for the early phases of temporary diabetes was indicated by a lack of severe islet damage and profound changes in many other organs related to carbohydrate metabolism. A pancreatropic principle in the extract was indicated by mitotic figures in islets, ducts and acini. The hydropic degeneration which develops later in the course of injections may possibly be explained by the continued action of the pancreatropic principle on beta cells.

The occurrence of wax-like substances from peaty fireclays of the Karroo System in South Africa is described by V. L. Bosazza. He was unable to extract the pigmenting material.

E. W. Knight Jones records the occurrence of *Phoronis hippocrepia* Wright in North Wales, pointing out the paucity of recent records of this form in Great Britain.

RESEARCH ITEMS

Further Concepts of Serbian Gypsies relating to Disease

Bibi, who brings disease to Gadže children, but protects gypsy children from every illness, says Alexander Petrovič (*J. Gypsy Lore Soc.*, Ser. 3, **18**, 4; 1939), among the gypsies of Golubinci is regarded as a hen. When she flies her chickens fly after her; and they are devils, witches, fever, cholera, diphtheria, and every kind of disease. Some believe that Bibi is in the whirlwind. They are afraid of the whirlwind, and believe that when it gets hold of a man he loses the use of an arm or a leg, or his speech. Bibi is found in dust: we breathe or swallow dust, and disease with it. Illness is caught at the new moon, and waxes and wanes with the moon. Other gypsies believe that cholera is brought to the village by a woman "dressed in black", who carries disease only to those houses which are unclean. They conclude that a man is saved from cholera who keeps his house clean. The Golubinci gypsies, on the contrary, with a similar belief as to the origin of the disease, have come to the opposite conclusion. Because Bibi does not like smoke, dust, dirty napkins, dirty clothes and greasy pillow-cases, and these things stifle her, she will flee. In a house where everything is clean, she enters, touches each inmate, and they die. In the spring when colds, fevers, etc., begin to be prevalent, small dolls are dressed in red, one of which thrown into the well drowns Bibi, the other suspended from a high pole, is Bibi's son, the devil who drives her away. The Golubinci gypsies believe that every illness comes from fever. This may account for the belief that Bibi is a hen. A man suffering from malaria trembles violently, just as a hen does, when she beats her wings as if shaking off something. Thus it is not the sick man who shivers and trembles, but the disease itself, the hen that is in him.

North American Indian Music

Miss Frances Densmore, in continuation of her studies of the music of the indigenous peoples of North America, has published songs collected among the Nootka and Quileute of Neah Bay, Washington, on the Strait of Juan de Fuca, near Cape Flattery (*Bureau Amer. Ethnol. Bull.*, 124; 1939). These 'songs of the sea' are here compared with those previously collected among Indians of the prairie, woodland, high plateau and desert. The people are hunters of the whale; they use wooden canoes, and in pursuit of their prey often put far out to sea. Though not of great stature, their physical strength is considerable. They were warriors who cut off the heads of their enemies and displayed them on poles before their village. The potlach was practised with lavish generosity. Among their principal foods were the oil and meat of the whale, the flesh of seafowl and other birds, potatoes, fern roots, grasses and water plants and various berries. Climatic conditions are unfavourable to the growth of grain. Their songs, of which 44 per cent have a major tonality as against 38 per cent in Pawnee and 71 per cent in the Ute repertoire, while they show the smallest percentage beginning on the octave above the keynote, are characterized by a small compass; 70 per cent have a compass of six tones or less, compared with 15 per cent in the songs previously analysed. The songs recorded are connected with every department of life and individual and communal activity. They are both ritual or magical in significance as well as purely recreational. One of the most interesting from the cultural aspect is the group associated with whaling in which the skilled whaler was assisted by a strong tumanos (guiding, protecting spirit) acquired as the whaler's first task in the course of prolonged fasting and prayer.

Inheritance of Cyanogenesis

R. D. Williams (*J. Genetics*, **38**, 356–366; 1939) shows that some plants of wild white clover (*Trifolium repens*) contain a cyano-glucoside. There is a large variation in the HCN content of the different plants. 1,495 plants resulting from a cross between individuals giving a positive and a negative reaction to the picrate paper test gave positive reactions while 2,473 plants from crosses between acyanogenetic plants gave negative reactions. Further crosses show that the presence of a cyano-glucoside is governed by an almost completely dominant gene *Ac*. Variation in the HCN content between individuals is probably due to modifying factors.

Genetical Analysis of Abnormal Chromosomes

The value of genetics in the analysis of cytological abnormalities is ably demonstrated by B. McClintock (*Proc. Nat. Acad. Sci.*, **25**, 405–415; 1939). An abnormal chromosome 9 of *Zea Mays* formed as the result of irradiation with X-rays possessed two centromeres. Therefore the chromosome will break at anaphase I. In order to discover the subsequent history of this chromosome, the behaviour of the genes *Yg C Sh* and *Wx* was studied in plants heterozygous for the abnormal chromosome. It was shown that in embryo and plant tissue the broken ends do not rejoin, but in the embryo sac and endosperm there is a cycle of breakage—fusion of broken ends—bridge formation—breakage at succeeding cell divisions. This phenomena can be followed by the appearance and behaviour of hybrid fruits, which are sometimes variegated as the result of loss of a gene through breakage and refusion of the chromosome.

Position Effect in Œnothera

D. G. Catcheside (*J. Genetics*, **38**, 345–352; 1939) has studied X-ray derivatives of the structural homozygote of *Œnothera blandina*. One derivative, *blandina*-a when crossed with *blandina* forms a ring of four chromosomes involving the chromosome 3·4 on which the gene *Ps* is known to be placed. *Ps* normally gives flower buds broadly striped with red separated by narrow green bands. In the heterozygote *blandina*-a-*blandina*, however, there are narrow ill-defined bands of red. By crossing the F_1 *Ps-blandina-a.Pr blandina* with *Ps blandina*, one *PsPs-blandina* plant in 96 plants occurred. This probably arose as the result of crossing over in the F_1 plant. The author therefore concludes that the activity of the *Ps* gene in *blandina*-a is reduced by its relocation in position relative to the material different from normal blandina.

Genetics of the Garden Nasturtium

EILEEN SUTTON (*J. Genetics*, 38, 161–176; 1939) reports the results of further genetical experiments on the garden nasturtium (*Tropæolum*). The gene *n* reduces the size of plant and of leaves and prevents the anther from dehiscing. The gene *m* gives a sheen to the petals, increases the *p*H value and shortens the flowering season. The effect of *m* on flower colour is to reduce scarlet to biscuit colour, red to mauve or brown, and pink to mauve. The factor *t* partially inhibits anthocyanin production. A gene *g* adversely affects the viability of the pollen-grain and, being linked with *B*, accounts for abnormal ratios of *B*. The genes *B* and *R* are linked with a cross-over value of 0·125. The biochemistry and interaction of characters and chromosome constitution of *Tropæolum* are discussed.

Invertebrates from Manchoukuo

FIVE zoological reports based on material collected by the expedition maintained by the Japanese in Manchoukuo during June–October 1933 under the leadership of Prof. Shigeyasu Tokunaga, of Waseda University, Tokyo, have been published (Rep. 1st Sci. Exp. Manchoukuo. Tokyo: Waseda University). The only earthworm reported is the widespread *Eisenia foetida*. Four trematodes are described, two of which, *Pneumonocces jeholensis* and *Harmostomum momiyami*, are new. The three leeches have all been recorded previously from Japan and China. The two major papers are those on mammals and molluscs: both of them have the text in Japanese and English and both are illustrated by good plates, coloured and plain. Tamezô Mori describes 21 species of mammals, of which three species and two subspecies are regarded as new. Only twelve were actually collected by the expedition; the rest came from the Pest Investigation Institute at Tang-liao. Only four species of molluscs were found, one of which, *Viviparus* (*Idiopoma*) *chengtehensis*, is new. The account occupies 222 pages (137 Japanese and 85 English) and is illustrated by 22 plates. It contains a detailed account of the anatomy of the species, a good deal of information of general interest, and a suggested revision of the Viviparidæ.

Wax Emulsions for Deciduous Fruit

FRUITS are still living organisms when separated from the parent plant, and this fact is responsible for the main difficulties of storage. Citrus fruits have been preserved in good condition for longer periods than normal by the application of a thin coat of wax; indeed, 80–90 per cent of the crops in California and Florida are so treated. Waxing lengthens the effective period of storage apparently by lowering the rate of respiration, and research work on this subject in America is now being directed towards the use of the process on deciduous fruits. Robert M. Smock, of Cornell University, reviews the progress of these investigations in the *American Fruit Grower* of August. Research is also in progress in the Universities of California and Maryland in addition to Cornell, and the main problem appears to be to diminish the rate of respiration, and check the evaporation of water from the fruit without stimulating anærobic respiration, with its accompaniment of bad flavour. Bitter pit and storage scald are reduced by waxing, under certain conditions, and the aroma of certain varieties like McIntosh is conserved. Considerable possibilities are revealed by the paper, but the exact conditions of treatment are not yet sufficiently standardized for general commercial application.

Helium-Neon Content of Sea Water

THE vertical distribution of oxygen in the deeper parts of the ocean shows a minimum concentration (which may be very pronounced) at depths of 200–1,000 metres. In parts of the Pacific there is virtually no oxygen, whilst in the Atlantic the minimum zone is seldom less than 30 per cent saturated and in the far north and south there is sometimes no minimum. Reported analyses of the helium-neon content of sea water showed an apparent minimum of the helium-neon mixture coinciding with the oxygen minimum. N. W. Rakestraw, C. E. Herrick and W. D. Urry (*J. Amer. Chem. Soc.*, 61, 2806; 1939), by a repetition of this work under more suitable and representative conditions, have shown that specimens of Atlantic and Pacific water are practically saturated with helium and neon at all depths investigated (from 0 to 3,000 metres) with no evidence of a minimum concentration at any depth. There is hence no relation to the depth of oxygen minimum. This result is in general agreement with other oceanographic evidence.

Magnetic Testing

RECENT developments of alloys for magnet steel which require very high magnetizing forces for magnetizing and testing have led to the production of high-field permeameters, and R. L. Sanford and E. G. Bennett, of the Bureau of Standards, describe the one adopted at the Bureau, which seems capable of a high degree of accuracy (*J. Res. Bur. Stand.*, 23, No. 3; September 1939). It is a double-yoke apparatus with the adjustable pole pieces placed diametrically. The yoke is of laminated silicon steel. The pole pieces are channelled, with filler pieces fitting closely in the channels and capable of adjustment so as to grip the specimen to be tested, or if the specimen is very short it is made to butt against the pole pieces. The magnetizing coils are wound mainly on the pole pieces with auxiliary coils on the yokes. The induction is determined by reversal of the magnetizing current and the magnetizing field by coils rotated suddenly through 180°, close to the surfaces of the specimen. Both may be determined at various points along the specimen.

Mechanical Force due to an Electron Stream

DR. P. SELÉNYI of the Tungsram Research Laboratories, Ujpest, Hungary, has sent an account of a measurement of the mechanical force exerted on an electrode by a stream of electrons. The electrons were accelerated from a filament to a gold-leaf anode suspended as a pendulum. The pressures observed were 5–20 per cent higher than calculated from the accepted value of e/m for electrons, and this difference is ascribed to radiometer effects. The author considers that this mechanical pressure requires for its explanation a 'true' as distinct from an 'electromagnetic' mass, for he points out that when a single electron approaches a metallic screen, the electrodynamic repulsion due to induced currents depends on the conductivity of the screen, which is contrary to experience; while with a steady electron beam, conditions are stationary and no repulsion due to induced currents is to be expected.

THIRD INTERNATIONAL CANCER CONGRESS

By Prof. F. C. Wood, Institute of Cancer Research, Columbia University

THE Third International Cancer Congress, held under the auspices of the International Union against Cancer, met in Atlantic City, New Jersey, U.S.A., during September 11–15, 1939, under the presidency of Prof. Francis Carter Wood of Columbia University.

Unfortunately the onset of war prevented many of the European delegates from attending, and Sénateur Justin Godart, president of the International Union against Cancer, felt that he could not leave France. A few English delegates, among them Dr. William Cramer of the Imperial Cancer Research Fund of London, were able to remain. Considerable delegations came from South America and Mexico, and Prof. R. Kinosita represented the Japanese Government. The total attendance was more than four hundred, and approximately the same number of papers were read.

A special feature was a group of evening lectures which presented general surveys of various aspects of the cancer problem and were prepared with the purpose of interesting not only the specialist but also the entire audience. In these lectures the subject of genetic susceptibility to tumour formation in mice was surveyed by Dr. C. C. Little of Bar Harbor, Maine. Dr. A. Lacassagne of Paris presented the relationship of hormones and mammary adenocarcinoma in the mouse, and, as he was unable to be present, his paper was read by the chairman. The paper of Profs. Kennaway and Cook, also read in their absence, dealt with the chemical compounds as carcinogenic agents, and Dr. William Cramer of the Imperial Cancer Research Fund spoke on some phases of the etiology of human cancer. Another interesting evening lecture was that on "Cancer and the Public Health" by Surgeon-General Thomas Parran of the United States Public Health Service. A scheme for the organization of a cancer clinic, with the methods of recording the facts concerning patients and the mechanical sorting of the cards on which records are kept so as to obtain the desired statistics within a short period, was presented by Prof. Fred J. Hodges of the University of Michigan. Recent advances in cancer surgery were discussed by Dr. Frank H. Lahey of Boston; and Prof. James Ewing of New York, under the title of "Cancer, Present and Future", summarized the main features of the Congress and indicated the direction in which research might proceed in the future. The evening lectures were exceedingly well attended not only by the members of the Congress, but also by the local medical fraternity, who desired to obtain the latest information on progress in the investigation and treatment of cancer.

Papers were presented in the following Sections: Biophysics; Surgery; Therapeutic Radiology; Statistics and Education; Genetics; General Pathology; Experimental Pathology; Diagnostic Roentgenology; and a General Section for those titles that could not be included elsewhere or were received too late.

The Section on Biophysics included studies on the relation between concentration of ionization and the biological effect; the comparative action of X-rays and neutrons; a comparison of biological and physical measurements of X-rays produced at voltages from 200 to 1,000 kv.; the action of radiation on protoplasm, and the effects of X-rays on different viruses and genes.

In the Section on General Pathology there was an interesting series of papers on the relation between treatment with œstrogenic compounds and the tissue changes produced. Two of the authors believe that the administration of these substances in physiological doses or even in fairly excessive amounts cannot be held responsible for the production of malignant tumours in man, thus differing from the results obtained on animals by Lacassagne, Strong, and others, in which a carcinogenic effect, though perhaps not rigidly proved, is strongly suggested. Important papers were read in this section on tumours of the central nervous system, including one on brain tumours induced in mice by methylcholanthrene. Another communication was that by Martland on the occurrence of cancer in persons who have received considerable quantities of radioactive substances either for therapeutic purposes or accidentally as in various industrial processes. Other papers dealt with tumours of the ovary, pancreas, and parathyroid.

The Section on Experimental Pathology had a very large number of papers and of such variety that every phase of cancer research was included, with a full discussion of the recent studies on leukæmia in animals and the correlations between this disease and human leukæmia, the possible relationship of viruses to cancer, and other questions.

Sessions of great interest to practising physicians and surgeons were the combined symposia of the Sections on Surgery and Therapeutic Radiology, with prolonged discussions on the value of pre- and post-operative radiation in the treatment of cancer of the breast, the proper method of handling node involvements occurring with cancer of the oral cavity, and similar problems which, since they have to be studied statistically on human beings, cannot yet be regarded as settled, because of the lack of extensive statistical records of patients treated in different ways.

The remainder of the programme was devoted to papers on roentgenological diagnosis, genetics, education and statistics, and other clinical and experimental investigations.

Owing to the present situation, it was impossible for the Executive Committee of the International Union against Cancer to make any decision as to the place of meeting for the next Congress. The delegates from South America, however, gave a very cordial invitation to the officers urging the suitability of Buenos Aires for the Fourth International Cancer Congress in 1942.

SAFETY IN MINES RESEARCH BOARD

THE seventeenth annual report of the Safety in Mines Research Board for 1938 has recently been published*. In referring to safety instruction, it is pointed out that teachers, managements and trade union officials are convinced of the value of safety instruction. Safety principles classes for boys are established in every coalfield and similar classes are being formed for adults. Many applications for permission to attend demonstrations at the Research Station, Buxton, have had to be refused on account of lack of accommodation, but during the year there were twenty-two demonstrations which were attended by 5,983 visitors, of whom 3,864 were adults and 2,119 were boys. After demonstrations of coal dust explosions, methods of firing shots and the testing of electrical appliances, discussions were held, usually initiated by some member of the research staff. Many lectures have been given in the coalfields by members of the staff to an estimated total of 16,000 persons.

Cinema Films, Lantern Slides and Exhibits. The Board has prepared cinema films, lantern slides and exhibits, which have been used by teachers and safety officers in connexion with their work. One hundred and twelve loans of cinema films, representing three or four hundred exhibitions in addition to two hundred exhibits, have been made, which indicates the popularity of this branch of the Board's work.

Dispersability of Stone Dusts. An underground gallery at the Station has been used for comparing the dispersabilities of dust deposits during explosions. Various stone dusts have been used separately in thin layers, and as mixtures alone and with coal dust. Work on this problem is being continued, but it can be stated that improvements in the dispersability of dusts is obtained by the addition of light precipitated carbonates. Carbon black causes remarkable improvement. The minimum speed of an air current required to disperse weathered gypsum is 3,400 ft. per minute, whereas with the addition of only 1 per cent of carbon black this speed is reduced to 2,100 ft. per minute. The nature of the action is being studied, but obviously a disadvantage in the use of the mixture is the darkening of the dust, which affects the illumination of roadway.

'Water-proofing' of Colliery Stone Dusts. If ordinary stone dust comes in contact with moisture either in the atmosphere or on the surfaces of roadway in mines, it will not retain its dispersability. Both in Great Britain and in the United States, dusts have been produced which are not readily wetted by water. The dust is ground limestone, with which is incorporated ¼ per cent of palmitic or stearic acid. These dusts are highly dispersable and resist damp atmospheres extremely well. Incidentally, the fatty acid protector is readily incorporated during the grinding of the dust, and there appears to be no reason why the process should not be applicable to other dusts.

Gob-fire Experiments. For many years work has been proceeding on gob fires. In the experimental chamber, heatings have taken place when warmed air has been passed through packs consisting of coal and dirt. This state has been reached when the ingoing air has been at temperatures as low as 150° F. The heatings have been within a foot or two of where the air entered the pack.

In one experiment the chamber was filled with coal from the roof coal above the Barnsley Bed less than 3 in. in size, of which one third was ground to pass through a ¼-in. sieve. After ten weeks a heating occurred. The temperature of the air was raised in stages from 160° F. to 212° F. and the rate of flow varied between 0·5 and 10 cubic feet per minute. A heating developed when the rate of flow was 5 cu. ft. per minute.

A similar experiment was carried out but without fine coal, and a heating developed in four weeks. When the temperature of the air was raised from 185° F. to 200° F., the carbon monoxide content of the return increased in six days from 0·002 per cent to more than 0·024 per cent.

Noise. Another interesting investigation is that concerned with the reduction of noise. It has been found that the proper maintenance of mechanical details and attention to the air exhaust is necessary to obtain substantial noise abatement. A silencer has been designed for use with pneumatic picks which adds 1½ lb. to the weight of the pick, equivalent to an increase in weight of 7 per cent. Good results have also been obtained by piping the exhaust air from the road rippers on the surface, and whilst this idea cannot be applied to portable machines underground, it might with advantage be used in connexion with stationary engines. The metallic ring can be reduced appreciably by drilling a ¼-in. diameter hole at a distance of about 12 inches from the shank of the pick steel and filling it with molten lead plugged with a steel cap.

Experiments are being carried out on sound absorption in connexion with the silencing of electric motors.

Health Researches. Experiments are in progress at the Physiological Laboratory, St. Bartholomew's Hospital, on dust inhalation and related problems. Cages of guinea pigs have been placed at selected positions at collieries working anthracite, and a large number of lungs have been examined. It has been noticed that the lungs of animals from the screens contain more dust than those of animals kept underground. Much work has been done on dust suppression, and with the aid of wetting agents it has been possible to design plant using : (*a*) a compressed air mist ; (*b*) a mechanically formed mist ; (*c*) turbulent passage through water ; and (*d*) filtration by means of a compressed metal wool mattress. Under practical conditions considerable improvement has been effected by the use of these appliances at loading points underground and in connexion with screening on the surface.

With regard to poisonous gases it has been shown that a high degree of protection against carbon monoxide can be obtained with a commercial canister. When tested against a 1 per cent mixture of carbon monoxide in air saturated with water vapour at 17° C. and flowing at a rate of 32 litres per minute, each canister had a total leakage of carbon monoxide of 960 c.c. in four hours, which is the limit set in the official tests of the United States Bureau of Mines.

J. CROSSLAND.

* Mines Department. Seventeenth Annual Report of the Safety in Mines Research Board, including a Report of Matters dealt with by the Health Advisory Committee, 1938. Pp. iv+123+10 plates. (London : H.M. Stationery Office.) 2*s.* net.

ARCHÆOLOGY IN PERU: RECENT PROGRESS*

THE sequence of cultures in Peru was first established on a scientific basis by the excavations of Max Uhle at Pachacamac and Moche; and this was in the main confirmed by A. L. Kroeber's field expeditions of 1925–26 and his classification of the Uhle collections in American museums; but the antecedents of the earliest and finest cultures, such as the Early Chimu and the Early Nasca, are still unknown. Dr. J. Tello's intensive field researches have led him to the conclusion that the Coast cultures were to some extent derived from the Highlands, disagreeing in this and in other respects with the Uhle-Kroeber scheme. He regards the 'Archaic Andean' as the earliest, extending throughout the Highlands. Dr. H. U. Doering has recently found at Pacatnámu superimposed burials, of which he regards the oldest as having 'Early Chimu' affinities.

In the Highlands, the Tiahuanaco cultures are generally recognized as being considerably pre-Inca. The cyclopean buildings of the Cuzco region have been supposed by some to belong to a pre-Inca megalithic period. A detailed study of the masonry in which cyclopean, megalithic, and ashlar styles are often intimately blended, now makes it difficult to sustain this view. H. Bingham's investigations at Machu Picchu provide good evidence of this blending of styles; but the pottery is typically Inca. In 1933 the Peruvian Government established an Archæological Institute at Cuzco in celebration of the fourth centenary of the foundation of Spanish Cuzco, and inaugurated an extensive programme of clearing, restoring and excavating on the sites of the Cuzco region.

Hitherto unknown buildings have been revealed above the citadel of Sacsahuaman, and much pottery and other artefacts have been excavated. All the architecture is purely Inca; but the Incas used different styles for different purposes, often combining two or more styles in the one building. The pottery is almost without exception of Inca types.

The use of radiophotography in the laboratory of the British Museum recently by Dr. H. J. Plenderleith and Mr. A. Digby has afforded interesting results regarding the technique of handle and spout attachment, which may prove of value in classification, dating, and tracing influences from one region to another.

Air photography has been used in recent years and led to the discovery and plotting of the 'great walls' of Peru flanking the Santa River in 1932.

Dr. Valcarcél has appealed recently for international co-operation in Peruvian archæological excavation, for which local resources are inadequate. It is to be hoped that British field archæologists will give some attention to the Peruvian area in the future, and that the study of American antiquities may be encouraged and placed on a sounder basis by the establishment of special departments for the subject in some of our universities and museums.

* From the Presidential Address to the Royal Anthropological Institute, by H. J. Braunholtz, delivered on June 27, 1939.

MARINE DEPOSITS OF THE ARABIAN SEA*

INVESTIGATING the many samples from 131 stations the author determines the distribution of the main types of marine deposits in the Arabian Sea. The new data confirm the essential facts given in Sir John Murray's latest chart. The transitional Globigerina ooze - red clay, however, is indicated separately on the new chart, as this mixed deposit is frequently difficult to assign to one or other of the component types. In several cases the distribution of the pelagic deposits is correlated with water movement, as in the Zanzibar Area. The Pteropod ooze in certain areas is shown to be correlated with the hydrographic conditions which cause a lack of oxygen and increased salinity resulting in a high death-rate in these molluscs. Special attention is given to the biological remains in all the samples as previous authors have worked mainly from the mineralogical and chemical point of view. The remains of organisms in the deposits have been separated out and the percentage remains of each of the common phyla determined. The total percentage of remains in the deposits is correlated with the depth, being high in shallow water, low in 500–600 metres, and then rising again in about 1,000 metres. This rise in the deep water is mainly due to the accumulation of Globigerina and other Foraminifera. Foraminifera are much the commonest constituents of these deposits, Globigerina being the chief genus which with other Foraminfera forms enormous areas of deep sea oozes. It is found that the green and brown muds have the largest foraminiferal fauna, and more than twice as many species occurred in the green mud deposits than in any other. In two instances only did any one species occur in great numbers—*Rhabdammina abyssorum* from a deposit of mud in the Gulf of Aden where the residue after washing consisted almost entirely of these shells, and *Dendrophrya ramosa* from a station in the Zanzibar area occurred in very large numbers.

The Priestman grab hauls give interesting results in the depth range of the larger animals obtained, and the different types of deposit are reviewed as animal habitats in the light of these hauls. It is found that green muds and the muds and sands from the lagoons are rich in life whilst grey muds and clays and light brown or yellow sands are almost without life. Certain groups are shown to live mainly or exclusively on the coarser deposits.

It is unfortunate that the coloured key to the separate chart of the Zanzibar area is very mixed up, the area of Globigerina ooze reaching out to the deep water and coloured pink being labelled Pteropod ooze, whilst the coral muds and sands are labelled Globigerina ooze and the Pteropod ooze is labelled Coral muds and sands.

* John Murray Expedition, 1933–34. Scientific Reports, Vol. 3, No. 2: The Marine Deposits of the Arabian Sea; an Investigation into their Distribution and Biology. By Dr. H. G. Stubbings. Pp. 31–158+8 plates. (London: British Museum (Natural History), 1939.) 15*s*.

SCIENCE NEWS A CENTURY AGO

William Murdock (1754-1839)

On November 15, 1839, William Murdock, the colleague of Boulton and Watt, died at his house, Sycamore Hill, Handsworth, at the age of eighty-five. He was buried in Handsworth Church, and his bust by Chantrey was placed there side by side with the memorials to Watt and Boulton. Murdock was born at Lugar, Ayrshire, on August 21, 1754, and after being trained as a millwright by his father, in 1777, at the age of twenty-three, entered the famous Soho works, Birmingham. In 1779 he was sent to Cornwall as an erector of pumping engines, and he remained there until 1798. Much of the success of the firm in the county was due to him. He was a man of fine physique, cool-headed, frugal, ingenious and resourceful. In those days only the principal parts of the engines were made at Soho and much remained to be done at the mine. Boulton spoke of Murdock as the finest erector he ever saw. In Cornwall, too, at Redruth, Murdock made his historic little model steam vehicle, and carried out his pioneering work on gas lighting. The latter formed the subject of a contribution by him to the Royal Society in 1808, for which he was awarded the Rumford Medal.

Returning to Soho in 1798, on the dissolution of the partnership of Boulton and Watt and the assumption of office by the sons of the founders two years later, Murdock became the presiding mechanical genius at the works, and during the next twenty years made notable contributions to mechanical engineering. The manufacture of gas-lighting plant was taken up in earnest and Soho may well be regarded as the cradle of the gas industry. Murdock also furthered the application of compressed air to machinery, constructing air motors and pneumatic lifts. His inventions included the sun and planet motion, cast-iron cement, a rotary engine, an improved boring machine, and the long D slide valve.

The United States Coast Survey

In its column of Weekly Gossip, the *Athenæum* of November 16, 1839, said: "We are glad to learn that at length some progress has been made in the survey of the coast of the United States of America—a subject of great interest to all maritime nations. So far back as 1807, a law was passed on the recommendation of Jefferson, authorizing the President to cause a survey of the coast of the United States . . . owing, however, to the external relations of the country at that period, the survey was, for a time, deferred . . . In 1832, however, it was recommenced with increased vigour. . . . From the report of the Superintendent, it appears that the work is completed throughout that part of the coast and adjacent waters lying between the eastern extremity of Long Island Sound, to the neighbourhood of Long Branch, New Jersey; and the necessary triangulations to pursue the survey have extended southerly to Cape May and northerly to Mount Carmel in Connecticut."

Ferdinand Rudolph Hassler, to whom the project was largely due, was born at Aarau, in Switzerland, in 1770 and, having made his mark as a mathematician, was engaged on a trigonometrical survey of his native country. Removing to America, in 1807 he was made professor of mathematics at West Point, and in the same year he submitted plans for a survey of the American coast. He died while directing the survey on November 20, 1843.

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Director of the Geological Survey—The Secretary, Civil Service Commission, 45 Upper O'Connell Street, Dublin (November 21).

Assistant in the Department of Physiology—The Secretary, University College, Dundee (November 30).

Lecturer (Woman) in Mathematics—The Principal, Training College, Lincoln.

REPORTS AND OTHER PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Experimental Researches and Reports published by the Department of Glass Technology, the University, Sheffield. Vol. 21, 1938. Pp. iv+342+27 plates. (Sheffield: The University.) 7s. 6d. [1610

National Central Library. 23rd Annual Report of the Executive Committee, 1938–39. Pp. 77. (London: National Central Library.) [1810

The Journal of the Institute of Metals. Vol. 64. Edited by S. C. Guillan. Pp. 428+37 plates. (London: Institute of Metals.) [1910

Metallurgical Abstracts (General and Non-Ferrous). Vol. 5, 1938. (New Series.) Edited by S. C. Guillan. Pp. viii+1036. (London: Institute of Metals.) [1910

The National Smoke Abatement Society. Tenth Annual Report 1939–40. Pp. 12. (Epsom: National Smoke Abatement Society.) [2310

Other Countries

Berzelius-Porträtt. Illustrerad beskrivning på Kungl. Vetenskapsakademiens uppdrag utgiven av Arne Holmberg. Pp. xvi+52+32 plates. (Stockholm: Kungl. Vetenskapsakademiens.) [1610

Indian Forest Records (New Series). Entomology, Vol. 5, No. 2: On the Biology of *Calopepla leayana* Latr. (Chrysomelidæ, Col.) and the Possibilities of Control. By P. F. Garthwaite. Pp. v+237–278+2 plates. (Delhi: Manager of Publications.) 1.12 rupees; 2s. 6d. [1610

Osiris, Vol. 7: Lettres inédites de Newton. Par Jean Pelseneer. Pp. 523–556. (Bruges: St. Catherine Press, Ltd.) [1610

Nyasaland Protectorate: Geological Survey Department. Colonial Development: Water Supply Investigation. Progress Report (No. 8) for the Year 1938. Pp. 22+4 plates. (Zomba: Government Printer.) [1610

Annual Report of the Public Health Commissioner with the Government of India for 1937. Vol. 1, with Appendices. Pp. viii+345. (Delhi: Manager of Publications.) 3 rupees; 5s. [1610

U.S. Department of Agriculture. Circular No. 529: Food Habits of Prairie Dogs. By Leon H. Kelso. Pp. 16. 5 cents. Leaflet No. 186: Domestic Mosquitoes. By F. C. Bishopp. Pp. 8. 5 cents. (Washington, D.C.: Government Printing Office.) [1610

Proceedings of the United States National Museum. Vol. 87, No. 3068: The *Heterelloides*, a Suborder of Paleozoic Cyclostomatous Bryozoa. By Ray S. Bassler. Pp. 25–92+16 plates. Vol. 87, No. 3070: New Turritid Mollusks from Florida. By Paul Bartsch and Harald A. Rehder. Pp. 127–138+plate 17. (Washington, D.C.: Government Printing Office.) [1710

Transactions of the San Diego Society of Natural History. Vol. 9, No. 14: Three New Worm Snakes of the Genus *Leptotyphlops*. By Laurence M. Klauber. Pp. 59–66. (San Diego, Calif.: San Diego Society of Natural History.) [1710

Bulletins of the Zoological Society of San Diego. No. 15: A Further Study of Pattern Dimorphism in the California Ring Snake. By L. M. Klauber. Pp. 24. (San Diego, Calif.: Zoological Society of San Diego.) [1710

New Zealand: State Forest Service. Annual Report of the Director of Forestry for the Year ended 31st March 1939. Pp. 37+22 plates. (Wellington: Government Printer.) 1s. 3d. [1910

Annual Report of the Indian Central Jute Committee for the Year 1938–39. Pp. iii+123. (Calcutta: Indian Central Jute Committee.) [2310

Journal of the Indian Institute of Science. Vol. 22A, Part 13: Crop Response to Chemical Oxidisers. By C. R. Harihara Iyer and R. Rajagopalan. Pp. 171–178. 12 annas. Vol. 22A, Part 14: Influence of Manganese and Iron Salts on the Oxidation of Organic Matter and Release of Plant Nutrients. By C. R. Harihara Iyer and R. Rajagopalan. Pp. 179–202. 1.12 rupees. (Bangalore: Indian Institute of Science.) [2310

Industrial Research Bureau. Bulletins of Indian Industrial Research, No. 14: Indian Refractory Clays. By H. Crookshank. Pp. vii+63. (Delhi: Manager of Publications.) 1.6 rupees; 2s. [2310

Annual Report for the Year 1938 of the South African Institute for Medical Research. Pp. 96. (Johannesburg: South African Institute for Medical Research.) [2310

Catalogues

Association Books, including some from Kelmscott Manor; Miscellaneous Recent Purchases also Botany, Gardening. (Catalogue No. 280.) Pp. 50. (London: Dulau and Co., Ltd.)

Brush-Koela Gas Producers. Pp. 4. (Loughborough: Brush Electrical Engineering Co., Ltd.)